REDLINED YESTERDAY AND REDLINED TODAY: THE HOME OWNERS LOAN CORPORATION'S LONG SHADOW

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The Home Owners Loan Corporation (HOLC), passed during the Great Depression, stabilized a mortgage market in which half of all debt was in default. While designed as short term relief, HOLC had a lasting effect on the mortgage market through institutionalizing the racist practice of denying mortgages to communities of color. Over subsequent decades, "redlining" funneled billions of dollars away from black neighborhoods and shaped segregation patterns and the racial wealth gap. Contemporary housing inequality is a result of this history of racialized exclusion. This paper combines newly-digitized archival data with data describing recent mortgage outcomes to investigate the intransigence of spatial inequality in housing finance. I show that borrowers in the early Twenty First Century were at a severe disadvantage when pursuing mortgages in neighborhoods redlined by HOLC appraisers in the first half of the Twentieth Century. Specifically, such applicants were more likely to be denied loans and receive subprime loans. Furthermore, foreclosures were more common in redlined areas during the Great Recession. This paper shows that the geographic patterns of vulnerability to exclusion and exploitation are remarkably stable and highlights the role of persistent institutional marginalization in replicating racial and spatial inequalities.

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Introduction

The Home Owners Loan Corporation (HOLC), passed in 1933, stabilized a housing market in which half of all mortgage debt was in default (Jackson 1985; Nelson et al. 2016). The program provided funds to refinance homes at risk of foreclosure and allow those who had already lost their homes to repurchase them. While designed as short-term relief, HOLC had a dramatic and lasting effect on homeownership through the replacement of a patchwork of mortgage practices with the long term, uniform payment mortgage (Fishman 1987). HOLC also institutionalized the racist practice of denying mortgages to people and communities of color. "Residential Security Maps" created by HOLC appraisers labeled black and immigrant neighborhoods as undesirable and outlined them in red.

The adoption of "redlining" by private lenders as well as subsequent federal programs (e.g. the Federal Housing Administration (FHA) and Veteran's Administration (VA)) funneled billions of dollars of mortgage credit away from black neighborhoods (Jackson 1985) and over the course of decades helped shape segregation patterns, homeownership inequality, and the racial wealth gap (Aaronson et al. 2017; Collins and Margo 2011; Conley 1999; Massey and Denton 1993; McCabe 2016; Roediger 2006). Home equity is the largest asset held by most Americans (Taylor et al. 2011) and disparities in access to affordable, high quality mortgage credit remain a driving force in the wealth gap between white and minority households (Faber and Ellen 2016; Flippen 2004; Krivo and Kaufman 2004) as well as a contributor to segregation (Bond and Williams 2007).

This paper connects the historic, explicitly racist practice of redlining to contemporary housing finance, which remains characterized by racial inequalities decades after discrimination was made illegal (Faber 2013; Hanson et al 2016; Munnell et al. 1996; Rugh et al. 2015). Specifically, I combine newly-digitized archival data cataloging HOLC neighborhood grades with Home Mortgage Disclosure Act (HMDA) data describing lending practices in recent years and RealtyTrac data on foreclosure activity during the Great Recession to show that areas redlined by HOLC underwriters in the 1930s had significantly higher subprime lending rates at the peak of the housing boom and accumulated more foreclosures during the subsequent recession than areas identified as "desirable". It was also significantly more difficult to secure loans in redlined neighborhoods well into the housing market's recovery (i.e. in 2015).

Although perhaps not surprising, it is important to document the rigidity of the economic organization of neighborhoods over time because it carries substantial implications for our understanding of how spatial stratification manifests as racial inequality. These results provide empirical support for claims that past settlement patterns and the ways such patterns were evaluated by institutions matters today (Krivo and Kaufman 2004; Logan 2016; Williams et al. 2005). Some of the relationship between HOLC grades and contemporary outcomes is due to socioeconomic disadvantage that characterizes redlined neighborhoods today as well as racialized selection into different neighborhood types. However, it is difficult to understate the culpability of HOLC—as well as those who adopted HOLC rules in subsequent decades—in shaping the segregation patterns we see today (Aaronson et al. 2017). Furthermore, to the extent that contemporary tract characteristics "explain" disparities across HOLC grades, this is same the logic that justified a practice we now consider to have been racist and have since made illegal.

Together, these patterns focus our attention on the central role of place in facilitating the intransigence of racial exclusion.

Background

The Home Owners Loan Corporation

HOLC was passed to stem the tide of foreclosures brought on by the Great Depression—half of the country's mortgage debt was in default at the time (Roediger 2006). This popular piece of legislation was seen by many as having saved the housing industry (Nelson et al. 2016) by providing funds for refinancing mortgages at risk of foreclosure and granting loans to those who lost homes to foreclosure to regain their homes (Massey and Denton 1993). In HOLC's first two years, it granted over $3 billion of loans on over one million mortgages, which represented one of every ten non-farm, owner-occupied homes in the country (Jackson 1985).

While HOLC was only designed as short-term relief, it had two dramatic and lasting impacts. First, the program institutionalized the long-term mortgage with uniform payments (Jackson 1985; Massey and Denton 1993). In doing so, it created the reliance on credit to finance homeownership and replaced "the crazy quilt structure of mortgage financing left over from the 1920s" (Fishman 1987 pp 175). HOLC was one of a suite of federal policies, which also included the FHA, responsible for creating the modern homeownership society and a pathway to the middle class (Collins and Margo 2011).

The second lasting impact of HOLC was on racial segregation. HOLC appraisers divided cities into neighborhoods and assessed the risk of lending to borrowers in neighborhoods based on sociodemographic characteristics of residents (e.g. income and race) as well as housing stock (e.g. age and state of repair). The resulting "Residential Security Maps" graded neighborhoods on a scale from "A" (i.e. most desirable) to "D" (i.e. least desirable). "A" areas were characterized by new housing stock, an exclusively white population, and demand that was presumed to be stable in the future. "B" areas were assessed as desirable, though past their peak, while "C" and "D" neighborhoods were considered to be declining and post-decline, respectively. Race and ethnicity may have been the most influential characteristics in determining a neighborhood's grade. In St. Louis, for example, not a single black household resided in an "A" neighborhood. Grades were color-coded, with "A" in green, "B" in blue, "C" in yellow, and "D" in red—this last category is the origin of the term "redlining" as poor neighborhoods and neighborhoods with even small black populations were outlined in red. Appraisers were gravely concerned with where black households lived and were moving because they were considered a disamenity and a signal of a neighborhood's decline. Residential security maps were often presented alongside maps of the black population (Jackson 1985).

HOLC did not create racism in real estate, but applied racist practices on an unprecedented scale. This institutionalization and legitimation of conflating mortgage default risk with racial isolation had dramatic consequences. Because of HOLC's racist nature, blacks were more likely to lose their homes during the Great Depression (Conley 1999). The vast majority of HOLC loans went to the two "most desirable" neighborhoods (Jackson 1985), channeling funds away from black and racially-mixed areas and towards white areas that were predicted to stay white (Massey and Denton 1993). The practice of redlining continued and evolved through its application by private banks and federal programs (Jackson 1985; Massey and Denton 1993; Roediger 2006). Together, the HOLC, FHA, and VA were in large part responsible for postwar suburbanization (Collins and Margo 2011; Fishman 1987; Jackson 1985), which encouraged white flight, the concentration of wealth and residential stability in

white suburbs, and the "spiral of decline" (Massey and Denton 1993 pp 55) experienced by many cities during the latter half of the Twentieth Century. Analysis of the long-term impact of HOLC showed that it caused racial segregation and was detrimental to home values (Aaronson et al. 2017). In fact, redlining continued to 1970 by the Federal Home Loan Bank Board (Jackson 1985). Housing inequality, facilitated by federal programs, became the largest contributor to the racial wealth gap (Conley 1999). The spatial and racial targeting of housing wealth also helped create and consolidate the contemporary white identity (Roediger 2006).

Racial and spatial dynamics of contemporary mortgage lending

Although redlining was made illegal by the Community Reinvestment Act in 1977 and mortgage discrimination was made illegal in 1974 by the Equal Credit Opportunity Act (Massey 2005), inequalities in mortgage outcomes have continued (Faber 2017; Munnell et al. 1996; Schafer and Ladd 1981; Ross and Yinger 2002; Turner 1999). Disparities in homeownership persist (Kuebler and Rugh 2013) and the racial wealth gap has risen in recent decades (Taylor et al. 2011)—in no small part due to racially disparate changes in home equity (Conley 1999; Faber and Ellen 2016; Flippen 2004; 2010; Friedman et al. 2013; Krivo and Kaufman 2004). Redlining limits the ability of minority households to pay for improvements, sell their homes, or refinance to pay for investments in education or entrepreneurship (Logan and Molotch 1987; Patillo 2008). Residential segregation by race may be declining[1], but remains a defining aspect of American social geography (Logan and Stults 2011; Massey and Tannen 2015) and is a consequence of mortgage outcome inequalities (Bond and Williams 2007). The suite of disadvantages facing nonwhite households pursuing homeownership likely also contributes to the fact that segregation is higher among homeowners than renters (Friedman et al. 2013).

The subprime boom and subsequent foreclosure crisis during the early Twenty First Century were a dramatic manifestation of the racialized nature of housing finance in America. People (Faber 2013; Gramlich 2007) and places (Hwang et al. 2015) of color were more likely to take on often-predatory subprime debt in the market's rise. Academic investigation (Massey et al. 2016) and whistleblower accounts (Powell 2009) suggest that subprime lending may have been a departure from the trend away from explicit racial exclusion and towards targeted racial exploitation. Additionally, scholars attributed the racialized nature of subprime lending to the fact that commercial bank avoidance of communities of color, which may constitute discrimination in itself (Turner 1999), created a market void, in which subprime lenders thrived (Gramlich 2007; Hernandez 2012; Squires 2004). This "reverse redlining" was made possible because earlier practices not only concentrated racialized poverty, but limited information about home lending available to minority communities and helped funnel minorities towards less favorable lenders and loan terms (Ashton 2008; Faber 2013; Hernandez 2012; Rugh and Massey 2010; Turner 1999; Yinger 1997). The geographic organization of this institutional absence interacted with persistent racial segregation to cluster vulnerability to predatory mortgage lending and foreclosures in communities of color (Hall et al. 2015; Rugh and Massey 2010; Rugh et al. 2015).

Although scholars have pointed to racial isolation as an important problem for decades (e.g. Massey and Denton 1993; Wilson 1987)—particularly regarding access to affordable financial and consumer services (Caplovitz 1968; Caskey 1994)—the growing evidence in support of these theories has led to increased attention on the importance of place as a site of stratification (Chetty et al. 2015; Sharkey and Faber 2015). Part of this work emphasizes a need

[1] Though there is evidence that racial segregation between municipalities has increased (Logan and Parman 2015).

to understand how people end up in places (Sampson and Sharkey 2008) and how (or whether) places change over time (Ellen et al. 2012; Firebaugh and Farrell 2016; Logan 2016; Logan and Zhang 2011). Concurrently, one overwhelming lesson to be learned from the subprime boom and foreclosure crisis is that place is a salient unit of analysis for institutional actors (e.g. mortgage lenders) and that spatially-determinant institutional practices (e.g. redlining and reverse redlining) can have dramatic, negative effects on racially isolated communities. Williams and colleagues (2005 pp182) argue that "the old inequality [in mortgage lending] helped make the new inequality [in mortgage lending] possible" by creating and concentrating racialized poverty—insuring that the effects of the previous generation's discrimination carries forward in time (Pager and Shepherd 2008) and illustrating how the "hierarchy of places" is facilitated by institutional actors (Logan 1978). Indeed, nascent evidence connects historic patterns of redlining to contemporary spatial inequalities (Aaronson et al. 2017)—further motivating exploration of the relationship between redlining yesterday and potential redlining today.

Mechanisms connecting past and present in housing finance inequality

Three related mechanisms may explain the extent to which spatially-organized mortgage inequality from the 1930s predicts contemporary inequalities in housing finance (i.e. mortgage lending and foreclosure). The first is differential selection across sociodemographic characteristics (e.g. race, income, and creditworthiness) into neighborhoods delineated by HOLC appraisers as desirable or undesirable. Scholars have repeatedly shown the ways in which race and income (both of individuals and places) shape mobility decisions, which—in aggregate—tend to sort households into racially- and economically-similar neighborhoods (Krysan and Bader 2009; Quillian 2012; Sampson and Sharkey 2008; South and Crowder 1998). Research has also documented intergenerational ties to place as a factor in the reproduction of spatial inequality through sorting of families by race and socioeconomic status (Sharkey 2008; 2013). "[H]istorical patterns serve as causes in themselves" in explaining the selection of individuals—along dimensions of race and class—into neighborhoods (Logan 2016 pp25).

Relatedly, work exploring the causes and consequences of the housing boom and bust has illuminated the intersecting roles of individual and community characteristics in shaping subprime lending likelihood (Been et al. 2009; Hwang et al. 2015), foreclosure propensity (Chan et al. 2013; Rugh 2015; Rugh et al. 2015), and the lasting impact of market tumult on mortgage outcomes (Faber 2017)—highlighting the importance of racialized selection as driver of housing finance inequalities. Therefore, we may observe higher income individuals with stronger financial histories choose to seek mortgage credit in neighborhoods previously assessed as A (i.e. "desirable") under HOLC, while poorer individuals with low credit scores apply for loans in D (i.e. "undesirable") neighborhoods. If this is the case, we may expect loan applications in D areas are more likely to be denied and be of lower quality (i.e. subprime) when approved compared to applications for mortgages in A areas. This same differential selection may also lead to disparities in foreclosure activity across HOLC grades if more financially-vulnerable individuals originated mortgages in D areas. Such individuals may be more vulnerable to job loss, own fewer financial assets with which to cushion unemployment, and/or be in a weaker position to modify a mortgage to prevent foreclosure.

The second pathway connecting mortgage disparities across eras is the concentration of socioeconomic disadvantage and racial isolation that not only characterized redlined neighborhoods during HOLC implementation, but carried forward in time. The path dependency of place and, specifically, inequalities between places means that existing settlement patterns

present an obstacle to change because of a legacy of disadvantage that created minority neighborhoods in previous generations (Logan 2016) and the combined impact of that disadvantage on the reputations that neighborhoods carry (Anderson 1999; 2011; Besbris et al. 2015; Jones and Jackson 2012; Small 2004). HOLC's institutionalization of the conflation of race and creditworthiness laid the foundation for contemporary patterns of segregation (Collins and Margo 2011; Conley 1999; Jackson 1985; Massey and Denton 1993; McCabe 2016; Roediger 2006). Recent research corroborates this claim with evidence that the lines drawn by HOLC appraisers exacerbated—and in some cases created—racialized neighborhood boundaries as well as spatial disparities in housing values, credit scores, and homeownership rates (Aaronson et al. 2017).

A wealth of research has documented the powerful role of neighborhood characteristics in shaping housing finance outcomes during and since the subprime boom. Loan application denial and subprime origination have been repeatedly shown to have been more prevalent in places characterized by low incomes and racial isolation (Faber 2017; Gramlich 2007; Hwang et al. 2015; Hyra et al. 2013). Foreclosures were also more common in segregated areas (Hall et al. 2014; Rugh and Massey 2010; Chan et al. 2013). Consequently, lenders may hesitate to grant mortgage credit in areas that suffer from both historical exclusion (i.e. D neighborhoods) and contemporary disenfranchisement due to the presumed (or assessed) financial risk of the people living in those neighborhoods and/or weakness of the local housing market. When loans are approved, they may be of higher cost (i.e. subprime) to balance this perceived risk. Again, sociodemographic inequalities on the neighborhood-level may also lead to increased foreclosure risk among borrowers in D neighborhoods compared to those in A neighborhoods through mortgage characteristic disparities (i.e. higher prevalence of foreclosure-prone subprime loans) or associated vulnerability to economic shocks (e.g. rising unemployment and plummeting housing values during the Great Recession).

The third mechanism is discrimination. In the wake of civil rights legislation, the practices responsible for racial inequality in the housing market have shifted from the now-illegal explicit exclusion to more subtle forms of implicit exclusion and exploitation (Massey 2005; Sharp and Hall 2014)—a "decentralization" of racism (Cutler et al. 1999). One consequence of this change in tactics is the difficulty of assessing discrimination (Pager and Shepherd 2008). Absent, for example, plainly racist underwriting manuals employed by lenders, disparities in lending outcomes between black and white neighborhoods could be attributed to the dynamics of selection or economic exclusion of communities of color outline above. Still, scholars have repeatedly shown racial discrimination to be prevalent in housing and credit markets (for reviews see Baldassarri and Abascal 2017; Bertrand and Duflo 2016; Pager and Shepherd 2008). Racial discrimination driven by individual characteristics (e.g. mortgage applicant race) may exacerbate housing finance disparities across HOLC graded areas caused by differential selection. For example, if blacks are more likely than whites to seek mortgages in D neighborhoods and blacks experience discrimination in the mortgage approval process (Massey et al. 2016), we may observe worse aggregate outcomes in D areas compared to A areas.

Lacking the data necessary to easily identify explicit discrimination based on place (i.e. "process-based redlining"), some scholars have chosen instead to investigate redlining from an aggregate perspective. "Outcome-based redlining" exists when minority neighborhoods experience worse mortgage application outcomes than comparable white neighborhoods (Dymski 2012; Pager and Shepherd 2008; Ross and Yinger 2002; Turner 1999; Yinger 1997). Adopting an outcome-based definition of redlining is particularly appealing in the context of the

evolving public discussion regarding the importance of intentional housing discrimination in shaping inequalities. Specifically, both the Texas Dept. of Housing and Community Affairs v. Inclusive Communities Project, Inc. Supreme Court decision (Texas Dept. of Hous. and Cmty. Affairs v. Inclusive Communities Project, Inc. 2015) as well as the U.S. Department of Housing and Urban Development's 2013 rules interpreting the Fair Housing Act (HUD 2013) have increased emphasis on the disparate impact of housing market dynamics, which is effectively an outcome-based understanding of the ways in which minorities are disenfranchised in the search for housing, including pervasive, ongoing discrimination at multiple stages in the search process. Disparate impact (e.g. empirically identified as "outcome-based" redlining) is a form of discrimination regardless of intention (Pager and Shepherd 2008). In addition to the immediate impact of redlining (i.e. the difficulty of acquiring prime credit in excluded communities), the resultant, spatially-organized reliance on subprime credit may interact with the concentration of socioeconomic disadvantage to make redlined communities particularly vulnerable to recession. Such cumulative disadvantage has been shown to have clustered foreclosure activity in black and Latino neighborhoods (Hall et al. 2015; Rugh et al. 2015). Moreover, black and Latino neighborhoods may have been additionally vulnerable to the foreclosure crisis because mortgage lenders treated these areas differently *during* the foreclosure process (Chan et al. 2013). The spatial organization of the Great Recession's temporally extended impact may have also disproportionately harmed black and Latino borrowers and places (Faber 2017).

These three interrelated mechanisms—selection, segregation, and discrimination—connect the explicitly racist practices of previous generations, which were organized spatially, to disparities observed today, which remain geographically clustered. The rigidity of racial disparities in homeownership, which remained effectively stable over the entirety of the Twentieth Century (Collins and Margo 2011), is an important manifestation of the intransigence of spatial inequality. Some take this even further, arguing that today's lending practices, which are ostensibly race-neutral but still produce dramatic inequalities, are a direct continuation of historical practices (Lipsitz 2009).

Data

My analytical strategy explores variation across neighborhoods with different HOLC designations in multiple outcomes (i.e. mortgage application denial, subprime loan origination, and foreclosure actions) and during three different time periods (i.e. 2006 and 2015 for loan application outcomes and 2007-2012 for foreclosures). In doing so, I investigate the persistence of spatially-organized mortgage lending inequalities. I focus on these three points in time to elucidate differences between dynamics during times of crisis—both in terms of vulnerability to exploitation (i.e. exclusion and subprime lending in 2006) and economic collapse (i.e. foreclosures during the Recession)—and a period of post-recession stability (i.e. 2015). While the first two periods are certainly unique, 2015 may be representative of things to come, as the housing market has recovered, federal protections against predatory lending have been put into place, and the subprime lending that characterized the housing boom has disappeared (Bhutta et al. 2015).

<u>Redlining in service of the Home Owners Loan Corporation (HOLC)</u>

Shapefile data[2] describing HOLC neighborhood ratings are made available by the Mapping Inequality Group (Nelson et al. 2016). The dataset includes the grades granted by HOLC

[2] I downloaded the most recent data at the time of this analysis—dated July 7, 2017.

underwriters for dozens of cities and some surrounding suburbs across 28 states.[3] The sample is dispersed across the country, with greater concentration in the Rustbelt and Northeast.

In ArcGIS 10.0, I spatially join the HOLC layer with census tract centroids in order to connect contemporary datasets organized on the tract-level. I only analyze census tracts in counties with at least once tract with a centroid that overlaps with HOLC-graded neighborhoods. Within the municipalities evaluated by the HOLC, appraisers provided grades for areas other than industrial or commercial areas, undeveloped areas, farmland, or places "sparsely built up." Tracts that were within counties assessed by HOLC though were in one of these land use categories at the time of appraisal are includes in the sample as "Not Graded".

Although HOLC boundaries do not perfectly align with contemporary census tracts, I am restricted by the fact that other datasets are organized by tracts. Because some tracts overlap with multiple HOLC areas, the assignment of HOLC grade to a tract based on its centroid may introduce noise into my analyses. In supplemental analyses, I merge census blocks, which are finer geographic units, to HOLC boundaries and create several tract-level aggregate measures based on block-level data. First, I calculate the "average" HOLC score among blocks within each census tract, in which A blocks are assigned a value of 0, B blocks 1, C blocks 2, and D blocks 3. Second, I calculate an average score weighting each block's contribution to the tract-level value by the proportion of the tract's land area represented by each block. Third, I calculate the modal HOLC grade among blocks within each tract. In all three of these measures, higher values indicate "less desirable" HOLC grades. Fourth, I calculate the percent of blocks within each tract that overlap with A, B, C, and D areas. Appendix tables A2 and A3 present results from models in which these measures are substituted for the tract-level dummy variable approach. These results support the main findings of this paper, though I proceed with the tract-level dummy variable approach because it is easier to interpret.

Home Mortgage Disclosure Act (HMDA)

Mortgage lending outcomes are assessed using HMDA, which contains information on each mortgage application received by lenders, including whether it was approved, the tract of the unit, and numerous other characteristics. In 2006, lenders were required to report whether the loan had an interest rate three or more points above the federal Treasury Rate. Following previous research (e.g. Been et al. 2008; Faber 2013), I use this variable to identify subprime loans among approved applications.[4] I use HMDA data to calculate three applicant-level measures: mortgage denial for both 2006 and 2015 (i.e. a dummy variable coded one if denied by the lender), and 2006 subprime lending conditional on approval (i.e. a dummy variable coded one if an approved mortgage qualified as subprime, zero if prime, and missing if the application was denied).

Because the HMDA dataset includes information about potential borrowers as well as the census tract in which the housing unit is located, it can be used to explore the role of neighborhood selection in shaping application outcomes. I create dummy variables for non-Latino black, Latino, and non-Latino Asian[5] applicants as well as dummy variables identifying

[3] Appendix Table A1 shows the number of HMDA sample observations by state. For a full list of cities in the Mapping Inequality Sample, visit the project's website (https://dsl.richmond.edu/panorama/redlining).

[4] This reporting rule changed in 2009, so comparisons across time of the prevalence of subprime lending are difficult—though the subprime lending that typified the boom disappeared after the collapse of the market (Bhutta et al. 2015).

[5] While I exclude applicants that were either missing race or were categorized as "Other Race" for parsimony, findings were substantively identical when I included them as separate racial categories.

female applicants, the presence of a co-applicant, refinance loans (compared to purchase loans), and conventional loans (as opposed to FHA, VA, Farm Service Agency, or Rural Housing Service loans). I calculate the natural log of the applicant's income and the size of the requested loan. The limitations of HMDA are well-documented. For example, it is missing down payment size and loan-to-value ratio, which shape loan outcomes (Turner 1999). Because HMDA lacks these important applicant characteristics, it cannot be used to definitively prove discrimination (Dymsky 2006). Still, HMDA remains the most comprehensive and publicly-available resource for studying lending.

Following sampling procedures used in prior work (Avery et al. 2007; Been et al. 2008; Faber 2013; Pettit and Droesch 2008), I compute these measures among owner occupied, first lien, one to four-family units. I exclude home improvement loans. My analytic sample includes mortgage applications within census tracts with centroids within counties evaluated by HOLC and have full covariate data. Of the 3,219,400 applications that were in counties with HOLC data in 2006 and 2015, 491,252 are missing at least one variable within the HMDA dataset or are identified as "other race". An additional 518 are missing Fannie or Freddie data and 256,591 are missing percent foreign born, or unit age. Finally, 34,504 are missing county-level change in percent black.[6] My final analytical sample contains 1,614,123 mortgage applications in 2006 and 822,412 in 2015.

Table 1 displays descriptive statistics for the HMDA sample. In both years, most mortgage applications were for units in C neighborhoods, while a small minority of applications were in A neighborhoods (historically, few neighborhoods were given A grades (Jackson 1985)). The percentage of applications for either of the "desirable" areas (i.e. A or B) was higher in 2015 than in 2006, which is consistent with the fact that the applicant pool was whiter and more affluent in the latter year. Denial was rarer in 2015 than in 2006—in part because applicants were more likely to be white and had higher incomes on average in 2015. The neighborhoods in which applicants were seeking loans also had fewer minority residents in 2015 than in 2006. The 2006 sample was much larger than the 2015 sample, which is indicative of housing market fervor during the subprime lending boom. The high minority percentage is a function of the fact that the census tracts defining this sample are disproportionately within cities, which tend to be more diverse than the country as a whole (in no small part because of HOLC and other policies, which facilitated white flight from cities throughout the Twentieth Century (Jackson 1985)). I explore this in more detail below.

[Table 1]

RealtyTrac

In addition to exploring mortgage application outcomes, I evaluate differences across HOLC-grades in foreclosure activity in the Great Recession using RealtyTrac data, which includes the address and date of every foreclosure between 2007 and 2012. I geocode every residential foreclosure notice or "pre-foreclosure" (i.e. either a notice of default or a lis pendens) and match

[6] Applicants in D areas have slightly higher rates of missing data (27%) compared to C (23 %), B (23 %), and A 23%) areas. Non-white borrowers in HOLC-defined areas are also more likely to have missing data (24% among Latinos, 16% among blacks, and 15 % among Asians) compared to whites (13%). It is difficult to speculate as to the direction of any bias introduced by missing data. However, the denial gradient in 2006 and 2015 as well as the subprime gradient in 2006 were in the same direction among observations with and without missing data (i.e. denial and subprime origination were more likely in areas graded below A. Therefore, I do not believe my main findings are threatened by missing data.

it to the tract in which it occurred. I then sum foreclosure notices at the tract-level. I focus on the first sign of financial distress in the dataset and do not allow individual units to count more than once if they progressed through multiple steps of the foreclosure process (e.g. if the household received a foreclosure notice and was then sold) because of the wide heterogeneity in the time between initial notice and the end of the process driven by state policy (Mian et al. 2015). Finally, I divide the number of foreclosures within a tract by the number of housing units in that tract to calculate a foreclosure rate. I include both rented and owned housing units in the denominator because there is no way to determine tenure in the foreclosure dataset.

My tract-level sample includes tracts with centroids within counties appraised by HOLC and with full covariate data. Of the 13,006 tracts in counties with HOLC data, 882 are missing covariate data. My final analytical sample contains 12,124 census tracts across 28 states. Table 2 displays descriptive statistics for the sample. Means deviate slightly from those in the HMDA sample because the unit of analysis is the census tract rather than the loan applicant. I discuss the representativeness of these tracts in detail below.

[Table 2]

Sociodemographic and housing conditions

I pair the data above with additional covariates to more fully account for two of the potential mechanisms connecting redlining yesterday to redlining today: selection and contemporary socioeconomic disadvantage. I do so not to identify a causal relationship between HOLC grades and contemporary outcomes, but to explore the extent to which correlations between these phenomena may be driven by continued economic inequalities between places and individuals. Although there are no publicly available data describing the credit conditions of mortgage holders on the census tract level, Freddie Mac (Freddie Mac 2014) and Fannie Mae (Fannie Mae 2014) provide estimates of variation in the creditworthiness of mortgage applicants on the ZIP3-level (i.e. the first three digits of a zip code). I use a crosswalk file provided by HUD to match census tracts to these larger units and calculate the percentage of owner-occupied, 1-4 unit properties acquired by either institution that were first time homeowners, the median credit score, and the median loan-to-value ratio[7] (LTV) in 2006 and 2015. While adapting ZIP3-level data for tract-level use is imperfect, these data provide insight into how borrowers of varying financial histories are selecting into neighborhoods characterized by different HOLC grades, which is reflected in improved model fit when predicting loan outcomes.

Better data exist to measure geographic disparities in socioeconomic disadvantage, which may dissuade lenders from granting loans. I calculate tract-level percent black, Asian, and Latino[8] using American Community Survey 5-year sample data for 2005-2009 and 2011-2015 from the National Geographic Information System (NHGIS)(Minnesota Population Center 2011). I also use NHGIS to calculate the percent of each tract that is foreign born, the median age of housing units, and the percent of units built before 1939—the latter two are measures of housing quality.[9] These covariates reflect the fact that HOLC appraisers were considerably

[7] For Freddie Mac data, LTVs below 6% and above 105% were excluded, while those below 0% and greater than 97% were excluded from the Fannie Mae dataset.

[8] Measures of racial makeup were normalized so percent white, black, Asian, and Latino summed to 100% of each tract's population.

[9] I attempted to include a tract-level measure of household income, but it was too strongly correlated with mortgage applicant income to avoid multicollinearity problems.

occupied with the demographic characteristics of the neighborhoods they were grading as well as the strength of the local housing market (Jackson 1985)—as are contemporary mortgage lenders (Chan et al. 2013; Faber 2017; Hwang 2015). Finally, I incorporate county-level unemployment rate from the Bureau of Labor Statistics and metropolitan statistical area-level housing price index (HPI) from the Federal Housing Finance Agency for 2006, 2010, and 2015. Ideally, I would be able to measure sociodemographic change on the neighborhood-level between the time when HOLC was evaluating neighborhoods and today, but those data are not publicly available in digital form.[10] In lieu of such data, I leverage county-level change in percent black between 1930 and 2000 from NHGIS as an estimate of demographic change.

Methods

My methodological approach is purely descriptive, as causal analysis of the long-term impact of HOLC grades on neighborhoods would likely be impossible given data limitations. The goal of these regressions is to explore the stability over time in the spatial organization of institutional marginalization and potential mechanisms connecting past to present.

I estimate each of the HMDA outcomes (i.e. subprime lending in 2006 and mortgage application denial in 2006 and 2015) using logistic regression. Loan application outcomes are measured as a function of HOLC grade (i.e. dummy variables for B, C, and D neighborhoods with A neighborhoods as the reference category), applicant characteristics (e.g. race and logged income); loan characteristics (e.g. logged loan size); tract characteristics (e.g. percent black); ZIP3-level median LTV, percent first time homebuyers, and median credit score; county-level unemployment and change in percent black between 1930 and 2000; and MSA-level HPI. Covariates are measured contemporaneously (e.g. I use 2006 measures of unemployment and HPI when estimating the 2006 subprime lending rate). The 2006 models are estimated using 2005-2009 ACS data while the 2015 models include 2011-2015 ACS data. I include dummy variables for census region and whether the tract was within a central city. Standard errors are clustered at the tract.

Foreclosure rate within tracts between 2007 and 2012 is estimated as a linear function of HOLC grades, the mortgage lending conditions in 2006 (i.e. characteristics of the loans at risk of default), as well as labor and housing market dynamics during the crisis (i.e. the potential exacerbating conditions). Specifically, I use 2006 HMDA data to calculate tract-level percent minority, average applicant income, and average loan amount, and 2006 Fannie and Freddie data to calculate ZIP-3-level median LTV, percent first time homebuyers, and median credit score. I use 2010 BLS data to calculate the county-level unemployment rate, 2010 FHFA data for the MSA-level HPI, and 2011-2015 ACS tract-level data for racial makeup, percent foreign born, and median unit age. Because subprime lending during the housing boom was a predictor of foreclosures during the recession (Hernandez 2012), models of foreclosure rates also include a tract-level measure of subprime lending in 2006 generated from HMDA data. As in HMDA estimates, foreclosure models include dummy variables for census region and whether the tract was within a central city. Standard errors are clustered by county.

[Figure 1]

[10] Although NHGIS does provide some tract-level data from the 1930 Census, it is only for a relatively small number of tracts and tract boundaries have changed dramatically in the intervening decades. Aaronson et al. (2017) generated measures of neighborhood-level demographic and housing characteristics for the period before HOLC implementation, though they relied on private data to do so.

Results

Long term stability in the spatial organization of housing finance inequality

Figure 1 displays the central findings of this project: decades after HOLC redlining, housing finance outcomes remain dramatically different between A neighborhoods and those with lower grades. Beginning with lending during the housing boom (Panels A and B), mortgage applications were approximately 10% more likely to be rejected and approved loans were approximately 15% more likely to be subprime in D neighborhoods than in A. Almost a decade later, substantial disparities in mortgage denial persisted, though were less severe than during at the peak of the market (Panel C). Finally, panel D indicates that neighborhoods with less desirable HOLC appraisals were also most impacted by the foreclosure crisis in intervening years.

[Figure 2]

Figure 2 displays the rates at which individuals of each racial/ethnic group applied for mortgages in each HOLC grade in 2006.[11] The most striking difference across groups is in A areas: approximately one in 10 white applicants were seeking loans in the highest rated areas, compared to one in 20 blacks and Asians and one in 50 Latinos. Whites were also much more common in B areas. The stark nature of these differences—all of which are all statistically significant—is not surprising given the literature on neighborhood preferences (Krysan and Farley 2002), the racial dynamics of neighborhood selection (Sampson and Sharkey 2008), and racial steering (Turner et al. 2012). These results suggest that racialized processes of selection may shape housing finance outcomes across HOLC areas. Specifically, the disproportionate presence of non-white mortgage applicants in C and D areas may help explain the higher denial and subprime lending rates in these same areas given racial disparities in income and wealth.

Table 3 shows racial and selected socioeconomic characteristics for all census tracts in my analytical sample, tracts in each HOLC grade, and the United States as a whole. Consistent with the mortgage applicant demographics, A tracts had larger white populations, while D neighborhoods had much larger black and Hispanic populations. Applicant incomes were also highest in A areas. Census tracts overlapping with C and D areas are more likely to be located in central cities and had dramatically higher subprime lending rates at the height of the housing boom. Differences were statistically significant and are consistent with research on the long term impact of HOLC on neighborhood disadvantage (Aaronson et al. 2017).

[Table 3]

These patterns are an important reminder of the racialized processes that facilitate segregation (Friedman et al. 2013) and a manifestation of the stability of racial isolation. The places that were predominantly white in the 1930s (and were rewarded for being so with desirable HOLC ratings) are still so today. Conversely, neighborhoods with large black populations in the early Twentieth Century (and were punished for being so with C and D ratings) are still predominantly non-white today. These patterns are important context for interpreting the across-HOLC differences explored throughout the remainder of this manuscript,

[11] The pattern was substantively identical in 2015, though members of each group were slightly more likely to apply for mortgages in A and B areas.

as the temporal stability of spatial inequality is a potential mechanism connecting mortgage disparities across eras.

[Table 4]

What connects past to present in mortgage lending?

So far I have established substantive and significant disparities in contemporary mortgage application outcomes across HOLC grades. This subsection presents regression estimates of these relationships not as an attempt as establishing a strict, causal relationship, but as an exploration of potential mechanisms connecting redlining during the HOLC era to inequalities observed today.

Table 4 displays selected results from logistic regression estimates of mortgage application outcomes in 2006 and 2015. Results are presented as odds ratios (i.e. exponentiated coefficients). The first column, which predicts mortgage application denial in 2006 based on HOLC grades and region, reflects the disparities shown in Figure 1: the likelihood that an applicant was denied rose from tracts graded A to those graded D. Potential borrowers were approximately 69% more likely to be rejected by lenders in D neighborhoods than A neighborhoods. Denial was also more likely in ungraded tracts within counties assessed by HOLC appraisers.

Column 2 shows that much of the variation across HOLC grades can be attributed to mortgage applicant heterogeneity (i.e. differential selection across neighborhoods). The magnitude of the odds ratios for the HOLC dummies fell yet retained significance, with denial 36% more likely in D tracts than A tracts. The relationships between applicant characteristics and denial were in the expected directions. Denial was more likely for blacks and Latinos, less likely for females, and declined with income. The predictive strength of HOLC grades weakened further once ecological characteristics were added to the model to account for the role of contemporary spatial inequality in shaping mortgage outcomes (Column 3). Potential borrowers in D areas faced 31% higher likelihood of rejection than those pursuing loans in A neighborhoods. Denial was also more likely in ungraded areas and cities as well as areas with larger minority populations and higher unemployment. Denial was less likely in areas with more immigrants and stronger housing markets.

The fourth through sixth columns show stronger relationships between HOLC grades and subprime origination conditional on approval at the peak of the housing boom. On average, subprime origination was 257% more likely among borrowers in D areas when compared to A areas. As with denial, borrower selection and ecological characteristics accounted for a large portion of this relationship, though the disparities between A and D areas remained significant and substantively meaningful upon addition of controls. Borrowers in D areas were approximately 79% more likely than those in A areas to originate a subprime loan after including these additional factors. With few exceptions, the coefficients for covariates were in the same direction as those in the model predicting denial.

A different pattern emerged in 2015. On average, areas marred by HOLC appraisers remained at a disadvantage in this relatively stable housing market, though disparities were not as stark as in 2006—denial was 37% more likely in D areas than A areas in 2015. The differences between these two time periods is likely due to the fact that mortgage applicants were much wealthier in 2015 (Table 1), which is in no small part because the credit market tightened up in the Great Recession's wake (Faber 2017). Mortgage applicant selection into neighborhoods

explained most, but not all, of the difference between the highest and lowest rated areas. Once ecological characteristics were added to the model, however, the relationship between denial and "less desirable" HOLC grades lost statistical significance.[12]

[Figure 3]

Because HMDA provides the race of the mortgage applicant, I am able to investigate heterogeneity in the relationships between HOLC grades and application outcomes. Figure 3 displays marginal effects from logistic regression models estimating each HMDA outcome interacting borrower race and HOLC grade (i.e. denial in 2006 in Panel A, subprime origination in 2006 in Panel B, and denial in 2015 in Panel C). These models include a full set of covariates. The clearest pattern across all three panels is the substantial disparity between black and Latino outcomes on one hand and white and Asian outcomes on the other. The former two groups were much more likely to be denied housing credit in both time periods and more likely to originate subprime loans, which is consistent with prior research (Faber 2013; 2017).

Within each racial/ethnic group, prospective borrowers generally fared worse in C and D neighborhoods compared to A and B areas, though there was heterogeneity across groups. For example, the A-to-D gradient for denial was steeper among whites compared to blacks and Latinos in 2006, while the opposite was true in 2015. Differences within racial groups and across both year and HOLC areas in applicant financial resources may explain the results from these interacted models. For example, the incomes of black and Latino mortgage applicants in C and D areas were much closer to those of white applicants in 2006 than in 2015. The ratio of black-to-white applicant income in D areas was 0.68 in 2006 and 0.54 in 2015. The Latino-to-white income ratio in D areas also fell from 0.87 in 2006 to 0.56 in 2015. A similar pattern exists in C areas. So to the extent that income inequality between racial groups leads to mortgage denial rate disparities between groups, the much smaller gap between white and black or Latino borrowers in 2006 may be driving the difference in racialized patterns across samples.

The difference in income inequality may also correlate with differences in inequalities along other measures of financial health absent from HMDA (e.g. down payment size, credit score, etc.) between 2006 applicants and 2015 applicants. Racial heterogeneity in the relationship between HOLC grade and subprime likelihood in 2006 was similar to denial likelihood in 2006, perhaps because of the same increase in financial similarity between white and black or Latino borrowers across grades. So variation between samples in intra-racial income distributions and selection differentiated by income help explain heterogeneity in the spatial patterns of mortgage application outcomes. Still, within no HOLC grade are the outcomes between white and Asian borrowers comparable to those of black and Latino borrowers.

The results presented so far show large disparities across HOLC grade and mortgage applicant race. Differential selection and the relative disadvantage of historically redlined areas both played large roles in shaping differences in mortgage outcomes across HOLC grades; however, there was a residual correlation between HOLC grades and 2006 outcomes. The selection of people of color into C and D areas may exacerbate racial inequalities.

[Table 6]

[12] Though the measures of HOLC grade generated from census blocks (Appendix Table A2) show a persistent and significant relationship between C and D grades and application denial in 2015.

Foreclosures

Not surprisingly, given disparities in mortgage outcomes across HOLC designations, tracts in A areas had lower foreclosure rates than tracts in areas with less desirable grades. Table 6 presents results from linear estimates of the number of foreclosure notices per housing unit between 2007 and 2012. The first column indicates that, on average, D areas experienced significantly higher foreclosure rates than A areas. Consistent with Figure 1, the coefficient for C areas was higher than that for D areas, though the two were not significantly distinguishable from each other.

As with the models of mortgage application denial in 2015, the disparities across grades were driven by borrower selection into neighborhoods as well as contemporary racial and economic isolation. The percent of mortgage applicants who were non-white in 2006 was positively and significantly correlated with foreclosure activity, while borrower income was negatively so. The prevalence of subprime lending among 2006 borrowers had a strong, positive relationship with subsequent foreclosures. Several ecological markers of disadvantage were also positive predictors of foreclosure (i.e. percent black, percent foreign born, and unemployment).

As with the loan application outcomes, the pooled results mask important heterogeneity. Unfortunately, RealtyTrac data do not include information on the race of the mortgage holder. Figure 4 displays marginal effects from models with 95% confidence intervals of foreclosure rate interacting neighborhood racial majority (i.e. if a racial group makes up at least 50% of a tract's population) and HOLC grade.[13] Several notable patterns emerge from this figure, the first of which is the relationship between HOLC grades and foreclosures within majority black tracts. In stark contrast to the main findings, foreclosures were highest in A areas. Because of this, the gap between predominantly black neighborhoods and other neighborhoods was largest in these places. Although this may seem surprising, it is in line with prior research documenting the unique vulnerability of relatively affluent African American individuals and neighborhoods during the housing boom and bust, which were often targeted by unscrupulous lenders *because* of their financial assets (Anacker et al. 2012; Faber 2013; Lacy 2012; Rugh and Massey 2015). Indeed, the 2006 subprime lending rate was 59% in A tracts that were predominantly black, compared to 26% in mixed A tracts, 20% in Latino A tracts, and 14% in white A tracts. The subprime rate *declined* from A to D among black tracts (to 27%), while it increased for all other tracts (to 28%, 20%, and 18% in Latino, mixed, and white tracts). The second important finding is that although differences between black and white tracts shrink (though remain significant) from A and B to C and D areas, the difference between Latino tracts and white tracts grows. The only significant differences between predominantly Latino and white areas, in fact, are within the lowest two grades.

Together, these results indicate that overall, areas redlined in the 1930s were most vulnerable during the foreclosure crisis. Most of this disparity was driven by racially and spatially disparate lending practices during the subprime boom and the concurrent, contemporary sociodemographic disadvantages of C and D areas. The few places identified as "desirable" by HOLC appraisers that also had black majorities in the early Twenty First Century fared the worse.

[Figure 4]

[13] These models include the full set of covariates from Table 6 except for census tract racial makeup, which is operationalized nonlinearly as majority race. Because there were too few census tracts with Asian majorities, they were included in the "Other" category.

Discussion

This project explores the persistence over a long period of time in the spatial organization of housing finance inequality. Borrowers in the early Twenty First Century were at a severe disadvantage when pursuing mortgagesin neighborhoods deemed "undesirable" by the HOLC in the first half of the Twentieth Century. Specifically, mortgage applicants at the height of the housing boom (i.e. 2006) were approximately 69% more likely to be denied a loan and 257% more likely to receive a subprime loan if approved for units in D neighborhoods compared, on average, to those in A areas. In 2015, well into the housing market's recovery, applicants in D areas still faced a substantial, 37%, disadvantage in the likelihood of approval on average. In the intervening years, foreclosures were much more common in D tracts. This constitutes evidence that those places redlined yesterday still faced "outcome-based redlining" as well as "reverse redlining" in more recent years.

Neighborhood selection differentiated by applicant race and income emerged as a driver of disparities across HOLC designations—especially in 2015. However, it is crucial to understand selection patterns as stratifying processes themselves, rather than solely as statistical nuisance—especially considering the highly segregated residential structure in which mobility decisions are made (Krysan and Farley 2002; Logan 2016; Sampson 2008, Sampson and Sharkey 2008). Whites were approximately twice as likely as non-whites to apply for mortgages in A areas (i.e. the areas that were historically rewarded for being predominantly white with affordable mortgage credit). To the extent that lenders still carry favorable views of A neighborhoods, which also have more than double the white population (as a percentage of total population) as D neighborhoods, the impact of segregated selection may carry forward as a cumulative disadvantage in the accrual of wealth among people of color (Rugh et al. 2015). These results emphasize the central role of place in facilitating racial exclusion and provide evidence of redlining.

The concentration of socioeconomic disadvantage in B, C, and D neighborhoods also explains some of the relationships between contemporary outcomes and HOLC's legacy. We must, however, contextualize these results within the history of housing exclusion. Attributing the inequalities across HOLC areas in foreclosure and lending activity to the uneven spatial distribution of the poor and people of color is precisely what HOLC appraisers were doing when evaluating neighborhoods—a practice we have since determined to have been racist. Furthermore, contemporary racial inequalities are a direct consequence of historic policies, including HOLC, and part of a long trajectory of structural disenfranchisement (Aaronson et al. 2017; Massey and Denton 1993). Fixating on racial (and spatial) disparities in asset wealth, for example, as justification for unequal outcomes is the equivalent of telling black and Latino borrowers "We can't give you a loan today because we've discriminated against members of your race so effectively in the past that you have not been able to accumulate any equity from housing to pass down through the generations" (Lipsitz 2009 pp14).

Still, I show that some disparities across HOLC grades persisted even after controlling for measures of selection and segregation, which raises the question of discrimination. Unfortunately, my data are insufficient to identify specific instances of discrimination organized around race or place. However, given the evidence of racial bias by multiple actors in the housing market—including predatory and exclusionary lending (Hanson et al 2016; Massey et al. 2016; Powell 2009; Munnell et al. 1996), racial steering (Massey and Lundy 2001; Turner et al. 2012), and differential treatment of borrowers facing foreclosure in communities of color (Chan et al. 2013)—it is difficult to dismiss discrimination as a contributor to these results. Perhaps

more important is the argument that disparate impact, regardless of intent, is a form of discrimination (Pager and Shepherd 2008).

Although the fact that the places that were disenfranchised yesterday remain so today may be expected in a regime of inequality that inhibits change over time (Logan 2016), the stability of the social meaning of place facilitates segregation and associated disparities in opportunity (Chetty et al. 2014; Sharkey and Faber 2014). The housing market not only provides most Americans their primary vehicle for wealth accumulation (Conley 1999; Flippen 2010; Friedman et al. 2013; Taylor et al. 2011), but access to other spatially-organized goods and services, such as quality schools, employment, and safety (McCabe 2016; Sugrue 2005; Williams et al. 2005). The overlap between racial isolation and patterns of mortgage exclusion helps explain persistent inequalities in these arenas.

When passed, HOLC facilitated residential and class mobility for many white households, while largely excluding people and communities of color (Jackson 1985). The segregated neighborhoods and avenues for asset accumulation created by HOLC continue to cast a shadow on contemporary mortgage markets. Relatedly, evidence of the temporal stability of the geography of creditworthiness supports arguments that efforts to empirically assess the presence of discrimination in the contemporary mortgage market may obfuscate the culpability of historic discrimination (Hernandez 2012; Lipsitz 2009). These findings also support calls for broadening the analytical frame used to understand racial stratification to include institutional processes (Krivo and Kaufman 2004).

This project is not without limitations. Because of data and methodological limitations, I am unable to provide evidence of a strict, causal relationship between HOLC appraisals and contemporary mortgage outcomes. For example, neighborhood-level characteristics are not publicly available in electronic form for the period before HOLC implementation. Similarly, data limitations preclude me from attributing these patterns to discrimination. HMDA is missing information that may be correlated with race and/or neighborhood selection processes, and manifest as disparities across HOLC areas (Dymski 2006). However, the results presented here still carry importance—particularly in light of recent developments in fair housing. Specifically, as legal and policy communities debate the importance of intentionality behind the practices that result in unequal housing outcomes (HUD 2014; Texas Dept. of Hous. and Cmty. Affairs v. Inclusive Communities Project, Inc. 2015), it is important to continue to document the ways in which inequality is reproduced in a spatially-organized market (Hernandez 2012).

The sample of census tracts and mortgage applications within those tracts analyzed in this paper are not meant to be representative of the country as a whole. As shown in Table 3, they are poorer, more urban, and more racially diverse than the United States. However, the unique characteristics of the analytical sample, which may have been directly caused by HOLC (Aaronson et al. 2017), do not detract from the findings presented here. This goal of this project was not to draw identify causality, but to descriptively investigate the persistence of inequality in housing finance and present evidence suggestive of the mechanisms connecting outcomes over time.

While I focused on households pursuing mortgage credit as well as those who were already holding home loans (i.e. those at risk of foreclosure) because this was the segment of the population directly affected by HOLC, my analyses ignore renters. Though racial segregation tends to be more dramatic among owners than renters (Friedman et al. 2013), this population may also be affected by the influence of a racially and spatially organized practice. For example, it is possible that the housing finance practices documented in this manuscript also limit the

options of those seeking to purchase buildings with the intention of renting in C and D areas. This, in turn, could manifest as lower-quality rental units. Additionally, if HOLC appraisals affected the intergenerational transmission of cultural capital related to mortgage acquisition (e.g. by fostering and segregating norms of homeownership in A areas), my sample may be excluding households that do not know how to buy a home but have the financial capacity to do so.

Despite these limitations, this paper has important implications for our understanding of spatial stratification and how that manifests as racial inequality. The connection between persistent mortgage exclusion and the prevalence of subprime lending at the peak of the housing boom (as well as the other measures of housing finance prohibition) supports spatial void theories of financial services inequalities (Gramlich 2007; Hernandez 2012; Squires 2004). The spatial manifestation of institutional marginalization, therefore, can lead to the emergence of new forms of exploitation, which—in a segregated society—carry racialized consequences (Hernandez 2012).

Similarly, these findings illustrate the role played by institutions in shaping inequality. Private financial institutions, in partnership with the federal government, placed neighborhoods on different trajectories almost a century ago based in large part on the presence of black residents (Jackson 1985). Lines drawn by HOLC appraisers segregated wealth from poverty for generations (Aaronson et al. 2017; Conley 1999; Massey and Denton 1993) and continue to structure opportunity in a racialized manner. The communities that were explicitly discriminated against for having black residents in the 1930s are still disproportionately home to minority residents.

It is crucial to recognize the substantial role that public policy played in shaping housing inequality—including the institutionalization of redlining via HOLC. Disrupting these patterns may require as expansive an effort on behalf of the federal government to desegregate and close racial wealth gaps. More broadly, these findings suggest that policies purporting to advance market-based solutions to social problems must consider the ways in which markets can perpetuate racialized inequality (Dymski 1999; Hernandez 2012).

While breaking a cycle of disadvantage that has lasted (at least) close to a century is a particularly difficult challenge, building an understanding of the temporal rigidity of the economic organization of neighborhoods is a crucial research task. This paper shows that the geographic patterns of vulnerability to exclusion and exploitation are remarkably stable and, perhaps, that the cumulative impact of opportunity deprivation may be particularly activated during periods of dramatic change. These findings help explain the intergenerational transmission of context (Sharkey 2008) and a potential way in which historical patterns replicate over time (Logan 2016)—fundamentally challenging the idea of America as the Land of Opportunity. Given the path dependency that explains much of the uneven development that has long characterized metropolitan areas, a key challenge is how to intervene in ways that will alter longstanding patterns.

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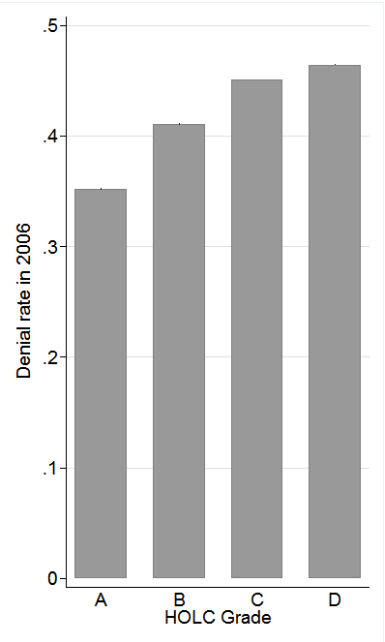
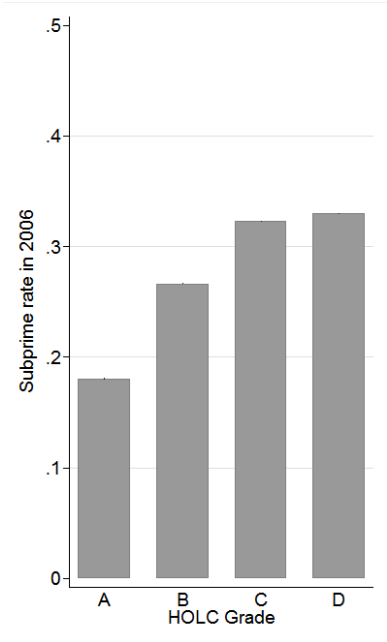
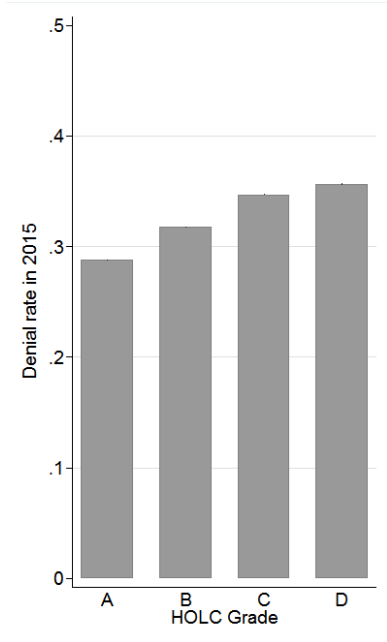
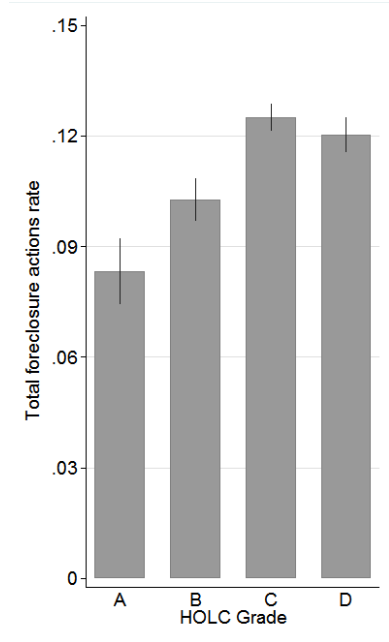
Figures and Tables

Figure 1: Average mortgage application outcomes and foreclosure rates by HOLC grade

Panel A: Mean application denial in 2006	Panel B: Mean subprime origination in 2006	Panel C: Mean application denial in 2015	Panel D: Mean foreclosure actions rate 2007-2012
			

Note: Histograms show mean values and 95% confidence intervals for the analytical sample. Confidence interval markers for denial and subprime origination are very small.

Figure 2: HOLC tract selection by race of mortgage applicants in 2006

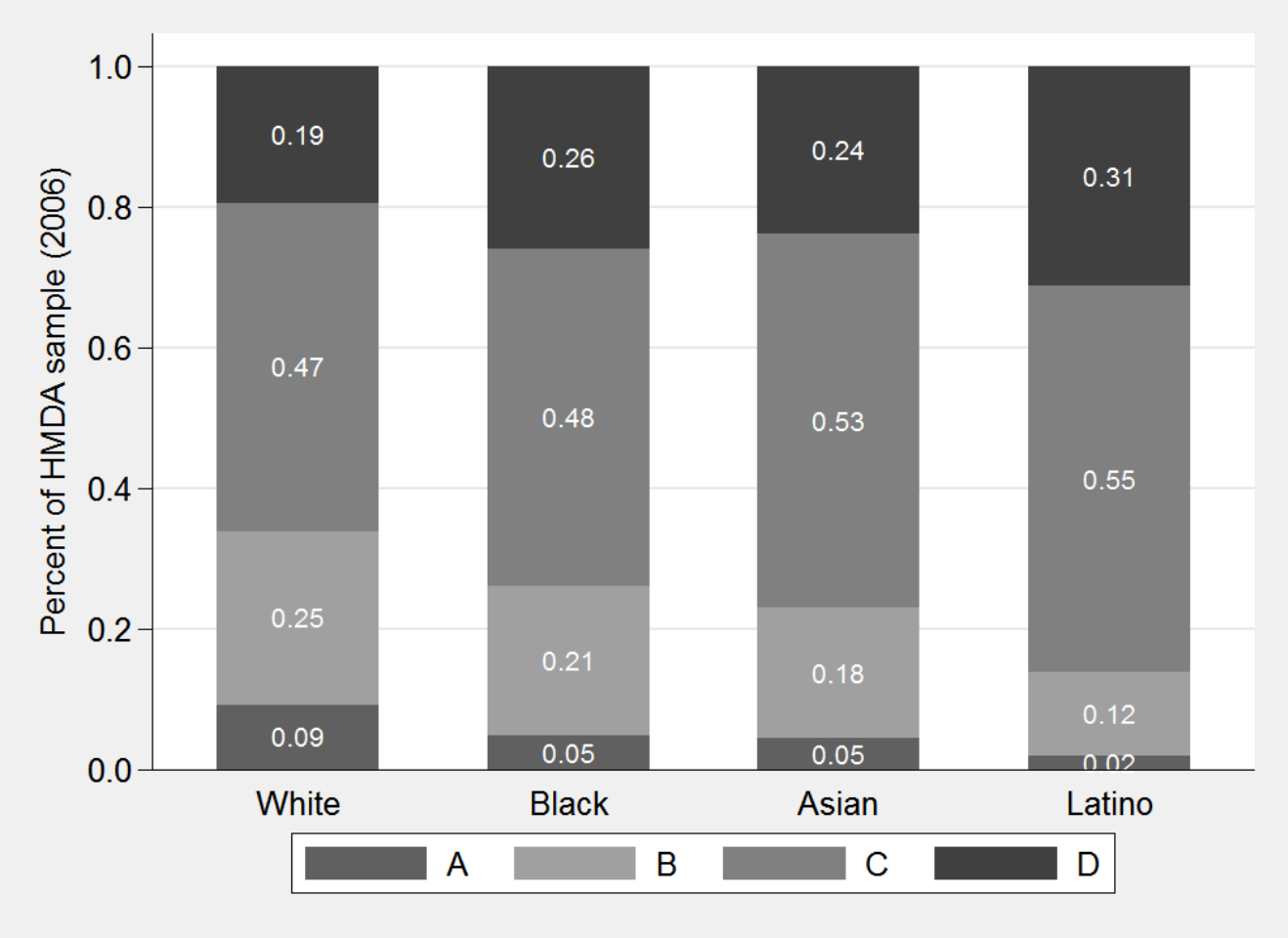
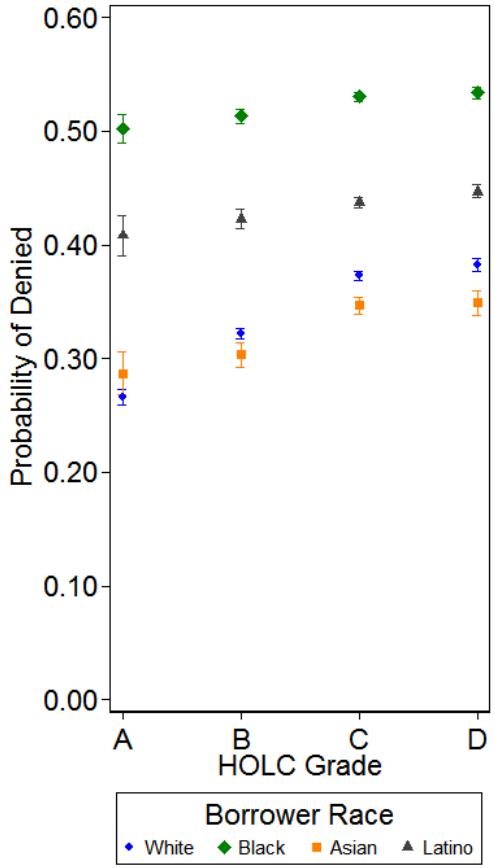
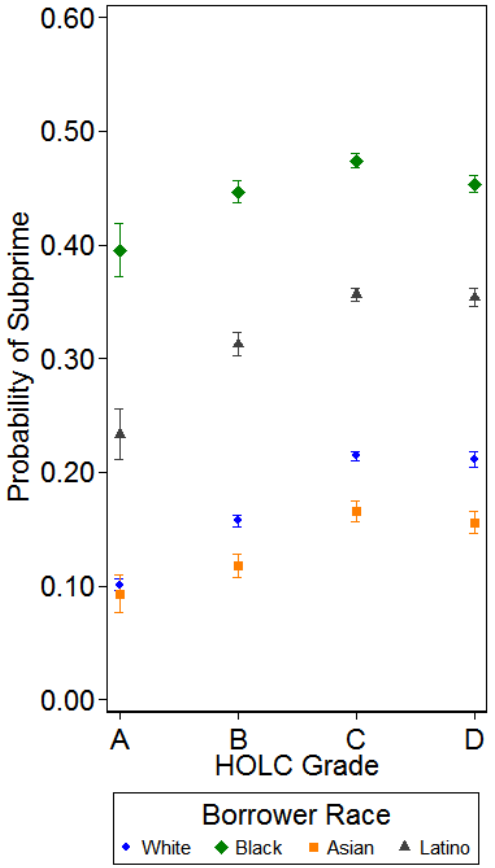
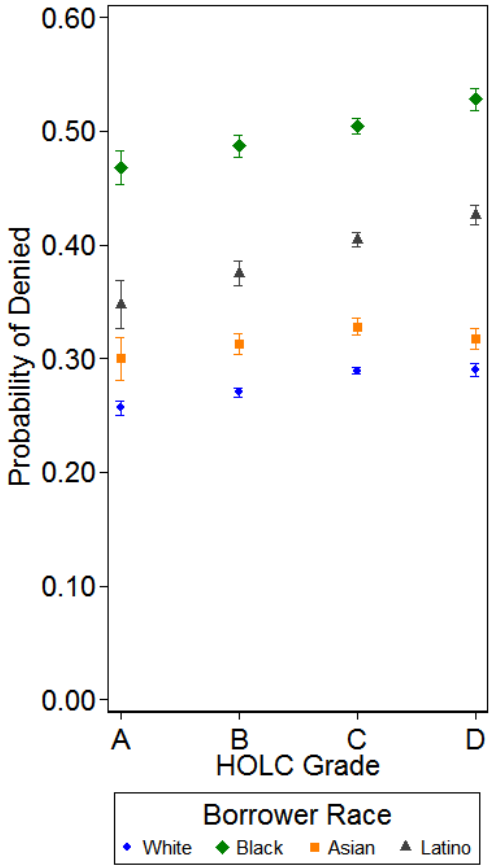


Figure 3: Marginal effects from logistic regression estimates of mortgage application outcomes interacting applicant race and neighborhood HOLC grade

Panel A: Prediction of application denial in 2006	Panel B: Prediction of subprime origination in 2006	Panel C: Prediction of application denial in 2015
		

Note: Marginal effects were estimated with models without full covariates. Figures show 95% confidence intervals.

Figure 4: Marginal effects from linear regression estimates of foreclosure activity interacting neighborhood majority race and HOLC grade

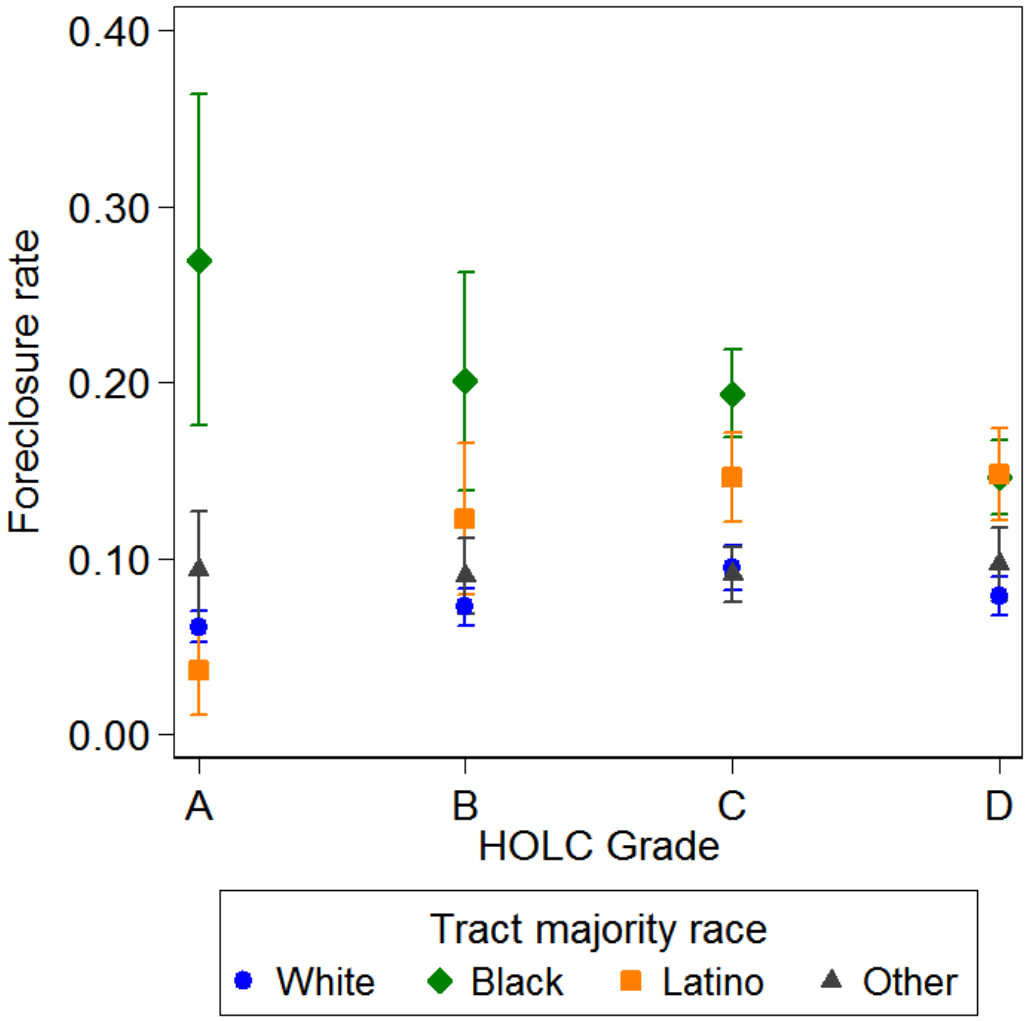


Table 1: HMDA analytical sample descriptive statistics

	2006				2015			
	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
HOLC Grade								
A	0.043	0.202	0	1	0.068	0.251	0	1
B	0.139	0.346	0	1	0.155	0.362	0	1
C	0.323	0.467	0	1	0.265	0.442	0	1
D	0.157	0.364	0	1	0.128	0.334	0	1
Not Graded	0.339	0.473	0	1	0.384	0.486	0	1
Application Outcome								
Denied	0.409	0.492	0	1	0.321	0.467	0	1
Subprime	0.265	0.441	0	1	0.044	0.205	0	1
Applicant Characteristics								
White	0.518	0.500	0	1	0.694	0.461	0	1
Black	0.263	0.440	0	1	0.105	0.306	0	1
Asian	0.050	0.217	0	1	0.086	0.280	0	1
Hispanic/Latino	0.170	0.376	0	1	0.115	0.319	0	1
Female applicant	0.406	0.491	0	1	0.347	0.476	0	1
Applicant income $1000s	94.058	133.609	1	9844	126.726	185.227	1	9866
Has coapplicant	0.783	0.412	0	1	0.671	0.470	0	1
Loan Characteristics								
Loan amount ($1000s)	242.637	241.596	1	24000	310.638	334.496	1	35000
Refinance	0.594	0.491	0	1	0.525	0.499	0	1
Conventional	0.965	0.184	0	1	0.794	0.404	0	1
Ecological Characteristics								
% Black	28.172	32.082	0	99.4	14.546	22.229	0	100

% Asian	6.109	9.630	0	88.3	7.543	10.642	0	91.4
% Latino	19.914	24.274	0	99.1	16.469	20.696	0	100
County unemployment rate	5.126	1.088	2.85	8.38	5.489	1.074	3.21	10.2
HPI	222.683	58.400	131	326	209.200	51.186	119	341
Median credit score	719.428	17.184	0	771	760.302	19.332	0	785
Median LTV	70.661	10.572	0	82.5	73.546	9.510	0	90
% First time buyer	10.978	6.138	0	36.4	51.260	11.250	0	83.3
% Foreign born	16.677	15.917	0	100	17.031	14.229	0	82.4
Median unit age	53.360	12.186	1	67	58.030	14.815	6	75
County Change in % black (1930-2000)	13.880	11.784	-13.5	46.7	11.782	10.478	-13.5	46.7
Central city (defined by Census)	0.691	0.462	0	1	0.658	0.474	0	1
Region								
Northeast	0.290	0.454	0	1	0.290	0.454	0	1
Midwest	0.367	0.482	0	1	0.307	0.461	0	1
South	0.129	0.335	0	1	0.131	0.338	0	1
West	0.214	0.410	0	1	0.271	0.445	0	1
	1614123				822412			

Table 2: Foreclosure analytical sample descriptive statistics

	Mean	Std. Dev.	Min.	Max.
HOLC Grade				
A	0.04	0.19	0.00	1.00
B	0.13	0.34	0.00	1.00
C	0.33	0.47	0.00	1.00
D	0.20	0.40	0.00	1.00
Not Graded	0.30	0.46	0.00	1.00
Preforeclosures rate	0.04	0.05	0.00	0.66
Aggregate borrower characteristics				
% Minority among loan applicants	47.61	32.27	0.00	100.00
Avg. loan applicant income	86.04	59.03	9.00	1768.00
ln(Avg. loan amount)	5.26	0.73	2.71	7.88
2006 subprime lending rate	27.23	27.07	0.00	302.00
Ecological Characteristics				
% Black	27.31	31.74	0.00	99.56
% Asian	7.38	11.51	0.00	89.55
% Latino	20.86	25.18	0.05	100.00
% Foreign born	19.21	17.24	0.00	82.45
Median unit age in 2015	61.45	13.40	6.00	75.00
Median credit score	758.49	20.12	0.00	785.00
Median LTV	52.66	12.47	0.00	83.33
% First time buyer	73.25	10.49	0.00	90.00
County Change in % black (1930-2000)	14.40	11.76	-13.49	46.68
HPI	203.21	49.52	119.14	340.62
County unemployment rate	10.30	1.90	5.65	17.29
Central city (defined by Census)	0.75	0.43	0.00	1.00
Region				
Northeast	0.37	0.48	0.00	1.00
Midwest	0.32	0.47	0.00	1.00
South	0.12	0.33	0.00	1.00
West	0.19	0.39	0.00	1.00
Observations	12124			

Table 3: Tract-level, racial and socioeconomic characteristics by HOLC grade and for the entire country as a whole

	Tracts	% White	% Black	% Asian	% Latino	% Homeowner	In central city	Avg. mortgage applicant income ($1,000s)[a]	Subprime rate '06
Entire sample	12124	46.53	27.31	7.38	20.86	47.64	75.37	86.04	27.26
HOLC grade									
A	473	72.96	15.54	5.68	7.56	69.46	64.48	144.70	14.92
B	1605	55.63	25.03	7.43	13.97	53.88	77.26	98.18	23.01
C	3959	40.83	28.15	8.57	24.55	43.43	79.49	78.02	29.67
D	2405	30.95	37.31	6.59	27.49	34.87	86.86	84.34	31.45
Not Graded	3682	55.48	22.38	6.80	17.28	54.98	64.01	82.94	25.38
United States	72539	62.95	13.51	4.50	15.91	63.28	41.61	94.13	0.24

[a] 2006 applicant income and subprime lending rate for the United States calculated among the 51,256 census tracts in the HMDA dataset

Table 4: Selected results from logistic regression estimates of mortgage application outcomes

	Outcome: Denial in 2006			Outcome: Subprime in 2006			Outcome: Denial in 2015		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
HOLC Grade									
B	1.320***	1.143***	1.146***	1.772***	1.459***	1.450***	1.142***	.995	.968
	(.046)	(.024)	(.020)	(.102)	(.049)	(.045)	(.025)	(.019)	(.018)
C	1.570***	1.291***	1.260***	2.449***	1.828***	1.728***	1.314***	1.053**	.985
	(.051)	(.025)	(.021)	(.131)	(.058)	(.051)	(.027)	(.020)	(.017)
D	1.689***	1.364***	1.316***	2.572***	1.788***	1.701***	1.365***	1.113***	1.013
	(.058)	(.028)	(.023)	(.144)	(.061)	(.054)	(.033)	(.023)	(.020)
Not Graded	1.341***	1.212***	1.245***	1.765***	1.569***	1.593***	1.199***	1.024	.988
	(.044)	(.024)	(.020)	(.095)	(.050)	(.047)	(.024)	(.019)	(.018)
Borrower Characteristics									
Black		1.728***	1.344***		2.908***	1.843***		1.958***	1.572***
		(.012)	(.010)		(.029)	(.020)		(.018)	(.017)
Asian		.998	.985		.762***	.793***		1.182***	1.120***
		(.011)	(.010)		(.016)	(.014)		(.013)	(.012)
Latino		1.375***	1.224***		2.297***	1.679***		1.461***	1.289***
		(.010)	(.009)		(.025)	(.018)		(.013)	(.012)
ln(Applicant income $1000s)		.786***	.803***		.814***	.878***		.727***	.738***
		(.004)	(.004)		(.006)	(.007)		(.004)	(.004)
Female applicant		.969***	.975***		1.029***	1.051***		.919***	.922***
		(.004)	(.004)		(.006)	(.006)		(.005)	(.005)
Ecological Characteristics									
Central city (defined by Census)			1.068***			1.012			1.026**
			(.008)			(.013)			(.009)
% Black			1.007***			1.011***			1.005***
			(.000)			(.000)			(.000)
% Asian			1.002***			.999			.999

			(.000)			(.001)			(.001)
% Latino			1.005***			1.010***			1.001***
			(.000)			(.000)			(.000)
% Foreign born			.999*			.999			1.005***
			(.000)			(.001)			(.001)
Median unit age			1.002***			1.011***			.999
			(.001)			(.001)			(.000)
% Of units built before 1939			1.000			.996***			1.000
			(.000)			(.000)			(.000)
Median credit score			1.000			.996***			.999**
			(.000)			(.000)			(.000)
Median LTV			.999			1.032***			.999
			(.001)			(.001)			(.001)
% First time buyer			1.001			.984***			1.000
			(.001)			(.002)			(.000)
County unemployment rate			1.146***			1.091***			1.059***
			(.005)			(.008)			(.005)
HPI			.998***			1.000			.999***
			(.000)			(.000)			(.000)
County Change in % black (1930-2000)			.989***			.989***			.997***
			(.000)			(.001)			(.000)
Constant	.463***	.286***	.101***	.154***	.027***	.009***	.406***	.679***	1.099
	(.015)	(.010)	(.029)	(.008)	(.002)	(.003)	(.008)	(.026)	(.270)
Observations	1614123	1614123	1614123	953541	953541	953541	822412	822412	822412
Census region dummy variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan characteristics	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Constant	.463***	.286***	.101***	.154***	.027***	.009***	.406***	.679***	1.099

Note: * p<0.05, ** p<0.01, *** p<0.001. Standard errors are clustered at the census tract level.

Table 5: Results from linear estimates of foreclosure rates

	Model 1		Model 2	
HOLC Grade				
B	.0075**	(.0023)	-.0033	(.0019)
C	.0159***	(.0030)	-.0016	(.0026)
D	.0157***	(.0044)	.0004	(.0030)
Not Graded	.0092*	(.0036)	-.0005	(.0023)
Aggregate borrower characteristics				
% Minority among loan applicants			.0002***	(.0001)
ln(Avg. loan applicant income)			-.0179***	(.0035)
ln(Avg. loan amount)			.0216***	(.0044)
2006 subprime lending rate			.0006***	(.0001)
Ecological Characteristics				
% Black			.0001*	(.0001)
% Asian			-.0004***	(.0001)
% Latino			-.0000	(.0001)
% Foreign born			-.0000	(.0001)
Median unit age in 2015			.0002***	(.0001)
Central city (defined by Census)			-.0050	(.0044)
Median credit score			-.0001	(.0000)
Median LTV			.0004*	(.0002)
% First time buyer			-.0003	(.0003)
HPI			-.0001	(.0001)
County unemployment rate			.0054*	(.0024)
County Change in % black (1930-2000)			-.0006	(.0003)
Constant	.0195***	(.0042)	-.0091	(.0642)
Observations	12124		12124	
Census region dummy variables	Yes		Yes	

Note: * p<0.05, ** p<0.01, *** p<0.001. Standard errors are clustered at the county level.

Appendix Table A1: Observations in the HMDA analytical sample by state

State	HMDA Observations
Alabama	21,971
California	433,220
Colorado	33,242
Connecticut	47,640
Florida	41,813
Georgia	41,342
Illinois	256,750
Indiana	78,335
Kansas	17,857
Kentucky	17,615
Maryland	60,611
Massachusetts	109,906
Michigan	172,857
Minnesota	29,823
Missouri	71,839
New Hampshire	7,602
New Jersey	144,102
New York	272,175
North Carolina	22,240
Ohio	149,772
Oregon	35,011
Pennsylvania	124,903
Tennessee	29,318
Texas	36,374
Virginia	39,880
Washington	67,140
West Virginia	5,085
Wisconsin	68,112

For a full list of cities in the Mapping Sample, visit the project's website (https://dsl.richmond.edu/panorama/redlining).

Appendix Table A2: Results from logistic regression estimates of mortgage outcomes using HOLC grades derived from census tract aggregates of census block data

	Outcome: Denial in 2006		Outcome: Subprime in 2006		Outcome: Denial in 2015	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Block average HOLC Grade	1.154***	1.073***	1.280***	1.120***	1.097***	1.023***
	(.007)	(.004)	(.014)	(.008)	(.006)	(.005)
Observations	1614123	1614123	953541	953541	822412	822412
Covariates	No	Yes	No	Yes	No	Yes
Block average HOLC Grade (Area Weighted)	1.156***	1.074***	1.284***	1.123***	1.097***	1.023***
	(.007)	(.004)	(.014)	(.007)	(.006)	(.005)
Observations	1614123	1614123	953541	953541	822412	822412
Covariates	No	Yes	No	Yes	No	Yes
Block mode HOLC Grade	1.135***	1.062***	1.245***	1.105***	1.085***	1.019***
	(.007)	(.004)	(.012)	(.007)	(.006)	(.004)
Observations	1614123	1614123	953541	953541	822412	822412
Covariates	No	Yes	No	Yes	No	Yes
Block % HOLC - B	1.209***	1.045**	1.505***	1.155***	1.017	.977
	(.030)	(.015)	(.067)	(.029)	(.019)	(.014)
Block % HOLC - C	1.442***	1.172***	2.094***	1.417***	1.220***	1.048***
	(.029)	(.015)	(.078)	(.031)	(.018)	(.013)
Block % HOLC - D	1.554***	1.213***	2.211***	1.402***	1.262***	1.049***
	(.034)	(.017)	(.088)	(.033)	(.022)	(.015)
Observations	1614123	1614123	953541	953541	822412	822412
Covariates	No	Yes	No	Yes	No	Yes

Note: * p<0.05, ** p<0.01, *** p<0.001. All models include dummy variables for census region. Standard errors are clustered at the tract-level.

Appendix Table A3: Results from linear estimates of foreclosures using HOLC grades derived from census tract aggregates of census block data

	Model 1		Model 2		Model 3		Model 4	
Block average HOLC Grade	.004**	.001						
	(.001)	(.001)						
Block average HOLC Grade (Area Weighted)			.004**	.001				
			(.001)	(.001)				
Block mode HOLC Grade					.003**	.001		
					(.001)	(.001)		
Block % HOLC - B							.004	.000
							(.004)	(.002)
Block % HOLC - C							.012***	.002
							(.003)	(.002)
Block % HOLC - D							.010**	.003
							(.003)	(.003)
Observations	12124	12124	12124	12124	12124	12124	12124	12124
Covariates	No	Yes	No	Yes	No	Yes	No	Yes

Note: * p<0.05, ** p<0.01, *** p<0.001. All models include dummy variables for census region. Standard errors are clustered at the county-level.