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We Built This: Consequences of New Deal Era Intervention in America's Racial Geography

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Abstract

The contemporary practice of homeownership in the United States was born out of government programs adopted during the New Deal. The Home Owners Loan Corporation (HOLC)—and later the Federal Housing Administration and GI Bill—expanded home buying opportunity, although in segregationist fashion. Through mechanisms such as redlining, these policies fueled white suburbanization and black ghettoization, while laying the foundation for the racial wealth gap. This is the first article to investigate the long-term consequences of these policies on the segregation of cities. I combine a full century of census data with archival data to show that cities HOLC appraised became more segregated than those it ignored. The gap emerged between 1930 and 1950 and remains significant: in 2010, the black-white dissimilarity, black isolation, and white-black information theory indices are 12, 16, and 8 points higher in appraised cities, respectively. Results are consistent across a range of robustness checks, including exploitation of imperfect implementation of appraisal guidelines and geographic spillover. These results contribute to current theoretical discussions about the persistence of segregation. The long-term impact of these policies is a reminder of the intentionality that shaped racial geography in the United States, and the scale of intervention that will be required to disrupt the persistence of segregation.

Keywords

segregation, housing, public policy, New Deal, redlining

America's stark racial geography remains a strong predictor of opportunity (Chetty et al. 2014; Sharkey and Faber 2014). Residential segregation shapes inequality in educational opportunity (Reardon, Kalogrides, and Shores 2019; Reardon and Owens 2014; Wodtke, Harding, and Elwert 2011), labor market success (Steil, De la Roca, and Ellen 2015), political efficacy (Ananat and Washington 2009), access to credit (Faber 2018; Hwang et al. 2015; Hyra et al. 2013), and a host of other aspects of U.S. life (De la Roca, Ellen, and O'Regan 2014). Despite evidence of moderating racial attitudes (Bobo et al. 2012) and declining housing discrimination (Turner et al. 2013), black/white segregation remains stubbornly high (Jargowsky 2018; Krysan and Crowder 2017; Logan 2013; Logan and Stults 2011). The persistence of racialized spatial inequality in the post-Civil Rights Era (Sharkey 2008, 2013, 2014) necessitates a look back to what precipitated the emergence

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of the black ghetto surrounded by a "white noose" of suburban affluence (Rothstein 2017:201).

Many scholars place blame on the federal government for creating this sociospatial dichotomy through segregationist housing policies initially developed during the New Deal and expanded in subsequent decades (Dreier, Mollenkopf, and Swanstrom 2005; Hirsch 1983; Krysan and Crowder 2017; Logan 2016; Massey and Denton 1993; Quinn 2019; Rothstein 2017; Taylor 2019; Wacquant 2008; Wilson 1997). The Home Owners Loan Corporation (HOLC), Federal Housing Administration (FHA), and GI Bill created the contemporary U.S. homeownership society but largely excluded people and communities of color from affordable mortgage credit through explicit and implicit means, thereby reifying racialized neighborhood boundaries. By giving federal backing to the idea that proximity to people of color necessarily leads to property value decline, these policies created a powerful financial incentive for white communities to segregate themselves (Jackson 1985). Discouraging white home-buying inside black neighborhoods and constraining black home-buying outside of black neighborhoods strengthened stereotypes about quality of life and structural strength of black neighborhoods, creating a "vicious housing cycle" (Kendi 2016:170) of self-reinforcing narratives that deepened racial stereotypes, the wealth divide, and racial isolation (Taylor 2019).

Although the racist nature of these policies is clear (Roediger 2006), there is little empirical evidence connecting their implementation to contemporary patterns of spatial inequality—or changes over time in those patterns. Recent work by the Mapping Inequality group (Nelson et al. 2019) to digitize HOLC "Residential Security Maps," which conflated neighborhood racial makeup with mortgage lending risk, has led to some work showing that federally-mandated redlining carried consequences for racial isolation and housing values at the neighborhood level (Aaronson, Hartley, and Mazumder 2018). However, no work has thus far explored whether these practices affected racial geography measured at higher levels of aggregation (e.g., cities and towns).

This is the first article to estimate the effects of early-twentieth-century housing policies on subsequent segregation patterns. Specifically, I leverage a full century of census data to show that the cities and towns appraised by HOLC became far more segregated than cities and towns ignored by HOLC. These findings are consistent across a range of specifications, including controlling for racial and socioeconomic characteristics prior to HOLC as well as change over time in those characteristics. Although HOLC appraisals were not randomly assigned (i.e., guidelines requested appraisals of all cities with populations above 40,000), I exploit imperfect implementation of this rule, as well as geographic spillover of countywide and metropolitan-wide appraisals, to provide further evidence of the impact of HOLC. Appraised and unappraised places were similarly segregated in 1930 (i.e., before HOLC), and both groups experienced increases in segregation between 1940 and 1960, but the rise was significantly steeper for cities and towns HOLC evaluated. HOLC-graded places continued to be more segregated than their ungraded counterparts through the "decline" of the American Ghetto (Cutler, Glaeser, and Vigdor 1999) during the latter half of the twentieth century. In 2010, the black-white dissimilarity, black isolation, and white-black information theory indices were 12, 16, and 8 points higher, respectively, in places touched by HOLC than in other cities.

These results illustrate the long-term impact government intervention can have on the hierarchy of places. HOLC placed cities on dramatically different trajectories in the 1930s, which is still evident today—a manifestation of a broader pattern of the "historically consistent, sequentially reinforcing practice of repression [of black Americans]" (Logan and Molotch 1987:131). The stability of HOLC's impact over most of a century also has crucial implications for ongoing theoretical discussions about how and why segregation is maintained over time. Specifically, the inheritance of HOLC's segregationist logic by a wide range of federal programs (Jackson 1985; Rothstein 2017; Taylor 2019) and institutional actors (e.g., mortgage lenders) (Connolly 2014) suggests the "momentum" Krysan and Crowder (2017) ascribe to individual-level dynamics may also apply to social policy and institutional decision-making. With growing evidence showing the centrality of segregation in the U.S. stratification system (Chetty et al. 2014; Sharkey and Faber 2014), these findings perhaps offer some hope that sociospatial inequality can be disrupted. If America's stark racial geography was intentionally constructed, work can be done to intentionally deconstruct it—although only through redirecting the momentum carried by public policy.

BACKGROUND

Policy-driven investments in place have helped shape the dramatically unequal distribution of opportunity across the United States, where select cities—and neighborhoods within cities—experience robust job growth, housing value appreciation, and upward mobility, while others are marred by crime and multigenerational poverty (Chetty et al. 2014; Logan and Molotch 1987; Massey and Denton 1993; Sharkey 2013). Research has documented the consequential and enduring effects of policies at all levels of government on the segregation of people, institutions, and infrastructure: from municipal-level zoning and land use decisions (Hirt 2015; Rothwell and Massey 2009), to the drawing of school district boundaries (Bischoff 2008; Owens 2016), to the federal expansion of the interstate highway system (Baum-Snow 2007; Krysan and Crowder 2017). Because of overlapping and reciprocal systems of racial inequality, these patterns can result in an uneven distribution of people of different racial groups across U.S. neighborhoods (Lipsitz 2011; Massey 2007). Although considered among the most substantial interventions into U.S. social geography (Aaronson et al. 2018; Hirsch 1983; Jackson 1985; Kendi 2016; Massey and Denton 1993; Sugrue 1996), little empirical work has evaluated the long consequences of federal housing policy during the New Deal.

New Deal Investment in Segregation

The Great Depression was not only an employment crisis, but a housing crisis—in 1933, approximately half of the nation's mortgage debt was in default (Jackson 1985). During that pivotal year, to stem the tide of foreclosures and spur economic activity, the Roosevelt administration created the Home Owners Loan Corporation (HOLC), a new federal agency, as part of the New Deal. HOLC granted loans to homeowners to help them avoid foreclosure and reacquire homes already lost to foreclosure (Jackson 1985; Nelson et al. 2019). HOLC also institutionalized the long-term, fixed payment mortgage, which largely replaced the ad hoc, patchwork system for purchasing homes that existed previously (Fishman 1987). In doing so, HOLC created the primary tool for wealth generation in the United States (Conley 1999; Oliver and Shapiro 2006).

As the federal government took an increasingly involved role in the provision of mortgage credit, its interest in assessing the default risk of potential borrowers also grew, leading HOLC to map the distribution of perceived risk within cities across the country. HOLC appraisers, in consultation with local lenders, realtors, and other industry representatives, gave neighborhoods one of four grades: "A" being the most desirable (displayed in HOLC's "Residential Security Maps" in green), "B" being slightly less desirable (blue), "C" being declining neighborhoods (yellow), and "D" being undesirable (red) (Jackson 1985)—also the origin of the term "redlining." Adopting the practices of the real estate industry, appraisers based these grades on housing characteristics, proximity to industry, and the sociodemographic characteristics of a neighborhood's residents.

Grades were geographically distributed in starkly segregationist fashion. The presence of low-income immigrants, or—most importantly—black families, effectively guaranteed a D grade. For example, in 1930, not a single black person in St. Louis—home to some 94,030 African Americans at that time—resided outside of D areas (Jackson 1985). By conflating race with mortgage default risk and home equity growth, these policies not only justified racial discrimination, but they also created a marketplace whose metrics of risk made discrimination necessary (Freund 2007). At times, this dynamic took physical form, as when a white suburb north of Detroit built a wall between themselves and the neighboring black community to the south to protect against integration (or "infiltration," as appraiser manuals referred to it) (Jackson 1985; Nelson et al. 2019).

HOLC made $3 billion worth of loans in its first two years, aiding one million mortgage holders, or one of every ten non-farm, owner-occupied homes (Jackson 1985). Further illustrating the program's scale, HOLC employed 20,000 workers across 400 offices (Quinn 2019). This federal involvement into the housing market was unprecedented at the time, but HOLC was designed to be a stopgap intervention. Had HOLC only served the short-term purpose of its intent, it may not have had a meaningful, long-term impact on America's racial geography net of endogenous racial preferences held by citizens and real estate interests within the cities HOLC evaluated. In other words, HOLC may have been a relatively "weak" institutional intervention.

However, the historical record documents that HOLC's practices of racial exclusion were adopted by subsequent federal programs, which were larger and more durable. Most notable among these were the Federal Housing Administration (FHA) and the GI Bill (Dreier et al. 2005; Jackson 1985; Quinn 2019). Between 1950 and 1960, a third of privately-owned housing units were financed by FHA and the GI Bill (Dreier et al. 2005). By 1972, FHA helped 11 million households buy homes and 22 million households improve their homes. Because these policies also made homeownership cheaper than renting in many cities, the U.S. homeownership rate increased from 44 percent in 1934 to 63 percent in 1972 (Jackson 1985).

The FHA and GI Bill embraced HOLC's neighborhood appraisal practices. FHA drew maps like HOLC's neighborhood security maps, although all but one archival record (the map of Chicago) was destroyed due to a lawsuit alleging racial discrimination (Greer 2014). Following HOLC, FHA maps excluded communities of color, effectively restricting billions of dollars of housing assistance to white Americans on the condition that they not buy homes in communities of color. The FHA also expanded segregationist efforts through the widespread promotion of racial covenants, which restricted home-buying opportunities for black families in white neighborhoods, further strengthening the color line institutionalized by redlining (Rothstein 2017). Over the decades, these massive programs, along with private lenders who followed the federal government's lead, funneled billions of dollars of housing investment away from poor, urban communities of color, and toward more affluent and suburban white communities (Jackson 1985; Taylor 2019). Thus, what HOLC ostensibly intended to be a short-term intervention may have resulted in quite a "strong" institutional mechanism due to its diffusion through and adoption by long-term programs, with dramatic implications for segregation over subsequent decades net of endogenous contributors to segregation.

New Deal housing programs certainly did not invent segregationist mortgage provision, but they institutionalized the practice, and implemented it at an unprecedented scale, leading many scholars to directly implicate HOLC, FHA, and the GI Bill in suburbanization, the exodus of white families from central cities, the creation of the black Ghetto (Hirsch 1983; Jackson 1985; Massey and Denton 1993; Quinn 2019; Sugrue 1996), and what then-HUD Secretary George Romney referred to as a "high-income white noose" around inner cities (Rothstein 2017:201). Freund (2007:116) argues that HOLC, in particular, "marks a notable transition between two distinct eras of housing economics in the United States," whereby ad hoc discriminatory efforts of individual homeowners and municipalities were replaced by widespread, federally supported—and federally funded—tools for segregation. Even well after HOLC was phased out and FHA manuals abandoned explicitly racist language, private appraisers continued the practice of systematically excluding communities of color from mortgage credit established by the federal government (Thurston 2018).

This article focuses primarily on mortgage lending, but scholars have documented numerous government and industry policies and practices that contributed to residential segregation. Exclusionary zoning practices of local municipalities (Hirt 2015; Rothwell and Massey 2009; Trounstine 2018), segregationist public housing construction (Rothstein 2017), discriminatory homeowner's insurance provision (Squires 1997), racial steering by real estate agents (Besbris and Faber 2017; Turner et al. 2013), and other manifestations of institutional bias (Bertrand and Duflo 2017; Korver-Glenn 2018) are layered on top of a racial geography heavily shaped by federal involvement in the housing credit market (Freund 2007; Logan 2016; Massey and Denton 1993; Rothstein 2017). Recent work has argued that New Deal redlining had a causal effect on neighborhood-level racial isolation (Aaronson et al. 2018), but no work thus far has explored the relationship between the legacy of these mortgage lending policies and subsequent trends in segregation at higher levels of aggregation—for example, between neighborhoods within cities.

Theorizing the Role of Redlining in the Dramatic Rise and Slow Decline of the American Ghetto

U.S. cities and metropolitan areas were characterized by moderate black-white segregation in the early twentieth century, but racial isolation increased dramatically after World War II. Fueled not only by housing policies (Massey and Denton 1993) but also infrastructure (Baum-Snow 2007) and education (Delmont 2016) policies, segregation peaked between 1960 and 1970 (Cutler et al. 1999). As racial attitudes moderated (Bobo et al. 2012) and federal legislation made explicit housing discrimination illegal (Massey 2005), black-white segregation declined in the post-Civil Rights Era, leading some to claim an end of a "Segregated Century" (Vigdor and Glaeser 2012) characterized by apartheid (Farley 2011). Other scholars contest the optimism of such claims, pointing out that black-white segregation remains stubbornly high (Krysan 2011; Krysan and Crowder 2017)—especially in historically hypersegregated areas (Logan 2013; Rugh and Massey 2014) and areas with large black populations (Jargowsky 2018; Logan and Stults 2011).

By using theoretical frameworks commonly applied to studies of spatial inequality, we can conceptualize an assessment of federally-mandated redlining's effect on segregation and—importantly—changing segregation patterns. The *place stratification model* posits that institutional practices create and reify racialized spatial boundaries. The segregation of black and white households is perpetuated over time through a relatively stable social hierarchy of neighborhoods and cities, within which residential mobility decisions are made (Alba and Logan 1993; Logan 1978; Logan and Schneider 1984; Stearns and Logan 1986). Following from this perspective, we should observe spatial inequality deepen as the result of institutional intervention in the housing market, such as federally mandated redlining. Because these policies concurrently drove investment away from already disenfranchised black communities and toward already advantaged white communities, they likely concretized (or exacerbated) the hierarchy of places (e.g., through differential housing quality).

Spatial assimilation theory largely points to disparities in socioeconomic factors between black and white households as drivers of differential neighborhood location (Alba and Logan 1993; Iceland and Wilkes 2006). As black families become similar to white families in income, wealth, education, and other measures of socioeconomic status, they will increasingly inhabit similar neighborhoods and cities. Because HOLC restricted homeownership to white households and linked proximity to black households to neighborhood decline, HOLC policies may have slowed black families' class mobility and "assimilation." The spatial manifestation of racial inequality ran parallel to a key component of economic inequality—unequal access to home equity, the key tool for asset accumulation. Put another way, redlining may have made it more difficult for black families to accumulate socioeconomic resources with which to "assimilate." These racist policies created a "vicious housing cycle" (Kendi 2016:170) by depressing housing values in black neighborhoods, decreasing demand for housing within those neighborhoods, and further depressing housing values.

Over time, the wealth gap has become a dramatic site of racial stratification (Conley 1999; Oliver and Shapiro 2006). In 2013, the median white household had $13 in asset wealth for each $1 held by the median black household (Kochhar and Fry 2014). Relatively fewer financial resources for black families can, in turn, lead to fewer residential mobility options. This lack of mobility, which reinforces housing stratification and the corresponding wealth gap, is again directly linked to the legacy of explicitly racist policies (Lipsitz 1998; Pager and Shepherd 2008).

Scholars have also argued that *racial preferences* perpetuate segregation over time, as bias toward neighborhood homogeneity can, in aggregate, result in racial isolation (Bruch and Mare 2006). By institutionalizing and legitimizing the practice of redlining, New Deal housing policies may have exacerbated, exaggerated, or locked in home seekers' racial preferences and created powerful financial incentives for real estate agents and mortgage lenders to make spatial segregation manifest. Specifically, the incorporation of widespread racist attitudes into federal policy may have provided institutional justification for those attitudes, thereby slowing or delaying the eventual moderation of racial attitudes in the latter decades of the twentieth century. Discriminatory policies fed racist ideas about black places (Hirsch 1983; Kendi 2016; Lipsitz 1998; Taylor 2019). Collective ideas about places—for example, negative stigma of poor communities of color (Besbris et al. 2015; Besbris, Faber, and Sharkey 2019; Jones and Jackson 2012)—can carry consequences for residential choices.

These overlapping theoretical perspectives illustrate the many intersecting ways federal redlining could have increased racial segregation. For example, we can look at how migration across cities may have been affected by HOLC. Racial differences in migration patterns are likely influenced by the pursuit of economic opportunity (i.e., place stratification), financial resources required for mobility (i.e., spatial assimilation), and perceptions of potential neighbors (i.e., racial preferences). Adjudicating between the relative importance of each perspective would likely be impossible due to data limitations and intersecting, self-reinforcing dynamics.

The social *structural sorting perspective* (Krysan and Crowder 2017) offers a holistic viewpoint from which to understand segregation and—importantly—what sustains segregation over time. Krysan and Crowder (2017) argue that many self-perpetuating mechanisms, such as the reduced economic mobility of black families or segregated sources of information, maintain segregation over time, through residential moves structured along racial lines. Although segregation is often considered to persist due to "inertia," these scholars suggest "momentum" is a more accurate metaphor due to social processes resulting in "the churning forward of racially disparate residential mobility patterns" (Krysan and Crowder 2017:11).

The structural sorting perspective is particularly useful in assessing whether HOLC was a "weak" or "strong" institutional intervention. Again, HOLC did not invent racist mortgage provision, but it invested heavily in a segregationist logic, which was implicitly and explicitly inherited by subsequent federal policies, including FHA and the GI Bill

(Jackson 1985; Rothstein 2017), highway development (Krysan and Crowder 2017), urban renewal (Nelson and Ayers 2019), and Civil Rights Era efforts to ostensibly expand black homeownership (Taylor 2019). On the local level, urban planning and zoning efforts often segmented municipalities to isolate white households from communities of color (Hirt 2015; Rothwell and Massey 2009; Sugrue 1996). Private mortgage lenders and real estate speculators throughout the twentieth and into the twenty-first century internalized the conflation of race, place, and mortgage risk to the detriment of African Americans (Connolly 2014; Faber 2013, 2018; Hwang et al. 2015; Hyra et al. 2013; Munnell et al. 1996; Rugh, Albright, and Massey 2015; Rugh and Massey 2010; Taylor 2019). The structural sorting perspective primarily focuses on individual- and community-level dynamics, but these and countless other examples illustrate that the ideas codified by HOLC may also carry tremendous "momentum" on policy and institutional levels. The self-reinforcing dynamics of overt and even unintentional actions sustain HOLC's racist logic in the policy sphere, proving it to have been quite a "strong" intervention.

DATA AND METHODS

My analytic strategy is designed to explore differences in segregation over time between cities and towns (i.e., census places[1]) that were appraised versus not appraised by HOLC. I focus on cities and towns because HOLC appraisals were generally[2] organized by place, and this unit of geography provides a large sample of both appraised and unappraised observations.

My primary concern is the extent to which black individuals were segregated from white individuals. I limit my analyses to these two groups for several reasons, the first of which is the fact that HOLC appraisals were quite sensitive to the presence of black residents—even a single black person within a neighborhood could lead to a D grade (Jackson 1985). Appraiser focus on African Americans is also evidenced by the fact that "Negro" population share was the only racial category in the neighborhood descriptions included with HOLC Residential Security Maps (Connolly 2014; Jackson 1985; Nelson et al. 2019). The second (and related) reason for this analytic focus is that the black-white color line is stronger than other racial boundaries (Wilson 1987, 1997), especially regarding residential segregation (Logan 2013). The third reason is data consistency. Over the course of the twentieth century, the way the U.S. Census categorized Hispanic/Latino and Asian groups changed far more dramatically than did definitions of white and black groups (Gibson and Jung 2002). Perhaps as a consequence of these changes, tract-level data on Latino populations is unavailable in 1950 and 1960 (MPC 2011).

The ideal data for this analysis would include longitudinal measures of race, socioeconomic status, and housing characteristics for geographically-stable neighborhoods before HOLC was created and in the decades that followed. Such data would allow me to measure the conditions within cities and towns prior to HOLC implementation, and to describe changing patterns of residential segregation and segregation's covariates within consistent geographic units. Unfortunately, such data do not exist, so I rely on imperfect measures of changing racial geography gathered from multiple census data sources. I discuss potential bias introduced from this technique in detail below.

Measuring Redlining

I combine two sources to identify cities and towns that were appraised by HOLC. The first data source is a list of surveyed cities generated via archival research by Hillier (2005).[3] Hillier (2005) notes that although federal guidelines required Residential Security Maps to be made for all cities with a population of at least 40,000, there was uneven and incomplete compliance. For example, Washington, DC, which had a population of 487,432 in 1930 is not included in the list.[4] Another notable characteristic of the list is that it includes several non-city geographies, such as Bergen, Essex, and Hudson Counties in New Jersey; "Greater Detroit" in Michigan; and "Metropolitan St. Louis" in Missouri. I supplement the Hillier (2005) list with georeferenced HOLC data provided by Mapping Inequality (Nelson et al. 2019), which include county and metropolitan appraisals, thereby allowing me to identify census places below the 40,000 threshold that were still surveyed by HOLC (e.g., Harrison, NJ, which had a 1930 population of 15,606). In total, there were 31 ungraded cities with 1930 populations above 40,000 and 118 graded cities with 1930 populations below 40,000. The most recent census data available at the time of HOLC implementation was from 1930.

I overlay Mapping Inequality shapefiles of neighborhood appraisal patterns with shapefiles describing contemporary (i.e., 2012) census place boundaries in ArcGIS 10. Any places that overlap with HOLC appraisal maps or places listed by Hillier (2005) are coded as "HOLC Appraised." This technique prioritizes parsimony, which may come at the expense of a more nuanced understanding of the effect of appraisal practices. For example, I am treating cities that were fully appraised and those that only partially overlapped with HOLC maps as equal. In results shown in Table S1 in the online supplement, I found that various alternative approaches to operationalize HOLC implementation (e.g., the percent of a city that was appraised and the percent of a city that received each grade), were poor predictors of subsequent segregation trends. Perhaps surprising, this result suggests the institutional process of just being appraised is all that matters (i.e., there are city-level effects).

Throughout the manuscript, I use the terms "appraised," "graded," and "surveyed" interchangeably to refer to cities and towns that at least partially overlap with HOLC Residential Security Maps or are on the Hillier (2005) list. Conversely, I describe other places as "ungraded," "ignored," "unappraised," and "non-appraised." Appendix Table A1 lists all graded cities in the analytic sample and notes whether they appear on the Hillier (2005) list or overlap with Mapping Inequality shapefiles. Forty-eight cities were solely listed by Hillier (2005), 48 more were identified via GIS analysis of Mapping Inequality data, and 108 were on both lists. Table S2 in the online supplement shows the main findings hold when I restrict measurement of HOLC appraisal to either Hillier or GIS measurement.

Tracking Change Over Time in Racial Geography

I combine data from several census sources to assess changes in place-level racial geography. I began with 1920, because that is the first year for which data on intra-city geography (e.g., wards) are available for either the complete count census or a 5 percent dataset.[5] I use individual-level data from the 1920, 1930, and 1940 Censuses—provided by the Integrated Public Use Microdata Series (Ruggles et al. 2019)—to calculate measures of segregation for each city in my sample in the two decades prior to, and the decade immediately after, HOLC implementation. Because census tracts were only drawn for some cities prior to the 1950 Census (Cutler et al. 1999; U.S. Bureau of the Census 1947), I measure segregation between wards within places in these three early decades. I aggregate individual-level counts of white and black residents to wards within cities, with which I calculate city-level black isolation, white-black dissimilarity, and white-black information theory indices (Reardon and Townsend 2018).

Although I lose the parsimony of focusing on one segregation measure, I use multiple measures for robustness. These indices have well-documented limitations (e.g., sensitivity to racial makeup and geographic unit choice [Logan and Martinez 2018; Reardon and O'Sullivan 2004]), so consistency of results across measures reduces the possibility that my findings are due to statistical construct. Each index is also relatively easy to calculate and interpret. Black isolation measures the typical neighborhood percent black for a black resident within a city; white-black dissimilarity measures the percent of either racial group that would need to change neighborhoods for there to be an even distribution of that group within a city (Massey and Denton 1993). The information theory index measures unevenness (Massey and Denton 1988) by comparing the diversity of neighborhoods (i.e., tracts) within a place to the overall diversity of that place. Similar to isolation and dissimilarity indices, the information theory index approaches zero if all neighborhoods within a city are as diverse as the city as a whole, and one if every neighborhood is racially homogenous (Lichter, Parisi, and Taquino 2015; Reardon and Firebaugh 2002; Theil 1972; Timberlake and Iceland 2007).[6]

The 1920 and 1940 complete count datasets include wards, but the 1930 dataset does not.[7] However, ward information is provided in the 5 percent sample of the 1930 Census. Using the 5 percent sample could introduce bias into my analyses (e.g., through noisier estimates of neighborhood racial makeup or upwardly biased segregation measures [Logan et al. 2018; Reardon et al. 2018; Spielman, Folch, and Nagle 2014]), so I conducted several robustness checks to validate use of these data. First, I turned to Cutler and colleagues' (1999) analysis of racial segregation in the early twentieth century to check my findings. My 1930 measures of dissimilarity, isolation, and information theory are strongly correlated with those calculated by Cutler and colleagues (1999) (.863, .942, and .857, respectively), and Table S3 in the online supplement shows that my main findings hold when substituting Cutler and colleagues' (1999) measures of 1930 segregation for those I calculated.

My ward-level measures of 1940 segregation derived from full-count census data are also correlated with those calculated by Cutler and colleagues (1999) (dissimilarity: .967; isolation: .974; information theory: .985). Although tracts were drawn for some cities in 1940 (Cutler et al. 1999), IPUMS individual-level data do not include tracts for the full sample dataset. However, NHGIS does provide tract-level data for some cities in 1940 (Manson et al. 2018), and my ward-level measures are strongly correlated with segregation measured with these data (dissimilarity: .689; isolation: .919; information theory: .740).[8] Table S3 in the online supplement shows once more that my main findings are insensitive to whether I used Cutler and colleagues' (1999) data or tract-level NHGIS data for measurement of 1940 segregation.

Because wards were, on average, larger than tracts (Massey and Denton 1993), comparing ward-derived segregation to tract-derived segregation in later years could be biased. Specifically, using finer geographic units generally leads to higher estimates of segregation (Logan and Martinez 2018). The 1930 5 percent sample as well as the 1940 full sample include information on enumeration districts, which were smaller than wards.[9] The 1950 1 percent sample available on IPUMS includes a synthetic identifier for enumeration districts, which is a number randomly assigned to individuals within an enumeration district. This synthetic enumeration district acts as a placeholder until the actual enumeration districts meet the confidentiality requirement of 72 years from the date the data were gathered. Table S4 in the online supplement shows the results hold when segregation is measured with enumeration districts—synthetic or actual—for 1930 through 1950 rather than wards. However, because the 1950 data are derived from a much smaller sample, I only have 44 observations for that year (i.e., I lose 56 observations in 1950). Together, this series of results strongly suggests the change in census geography from wards to tracts is not driving the results. I proceed with ward data for consistency in the pre-treatment period (i.e., because enumeration districts are unavailable for 1920) as well as concern that segregation may not be accurately calculable based on a 1 percent sample among so few cities in 1950.

I also aggregate individual-level data from the 1920, 1930, and 1940 Censuses to the place-level to measure sociodemographic conditions within cities and towns prior to HOLC implementation and in the decade immediately after. Specifically, I calculate measures of characteristics known to have been of concern to HOLC appraisers (Jackson 1985): total population, percent black, and percent foreign-born among whites. I also calculate the ratio of black homeownership to white homeownership as a measure of socioeconomic disparity between the two races. Although HOLC appraisals were influenced by other sociodemographic characteristics, I am limited by the variables measured consistently by the census from 1920 to 2010. For example, housing characteristics are left out of my analyses because they are unavailable on the place-level for several years. As described in detail below, there are additional characteristics I can measure for 1930 alone, although my preferred models rely on place fixed effects rather than these covariates.

Tract-level data become available in 1950, but place-level data do not exist before 1970, so I aggregate tract-level data from NHGIS (Manson et al. 2018) to places (as defined in 2012) using ArcGIS. Specifically, I join 1950 and 1960 census tract centroids to 2012 census place borders to estimate place-level characteristics. Because NHGIS data do not distinguish between black homeowners and other non-white homeowners in 1950 or 1960, I calculate the homeownership ratio using the ownership rate among all non-white homeowners in these two decades. Data are more consistent after 1960. NHGIS provides longitudinal, place-level data for population, racial makeup, percent foreign born, and racially-disaggregated homeownership rates by decade from 1970 through 2010. I calculate measures of black-white segregation for cities and towns between 1970 and 2010 using data from the Neighborhood Change Database (NCDB), which provides geographically stable tract boundaries. Table S5 in the online supplement summarizes the data sources used in this article.

Combining data across multiple sources and time periods introduces risks into my analyses. For example, I aggregate tract-level data from earlier decades to 2012 place-level boundaries in an effort to measure changing social conditions within as consistent a geography as possible. To the extent that place boundaries changed over time, this empirical choice could result in segregation calculations that include neighborhoods technically outside of city limits in any given year. Unfortunately, because place shapefiles are unavailable via NHGIS for decades before 1980, it is impossible to identify the extent of change over time. It is also unclear whether resultant inaccuracies in measurement of segregation or covariates would lead to upward or downward bias in coefficient estimates. Any noise introduced by these data limitations will likely affect (and likely inflate) standard errors—there is no reason to believe this noise is non-random or differentiated by HOLC status. I discuss strategies to address these estimation problems below.

Analytic Sample

My primary analytic sample includes every place-year that meets several criteria. First, the place must be observed in 1920 or 1930 (i.e., before HOLC implementation) and at least once after 1930 (i.e. after implementation). Second, the black population in any observed year must be at least 100, and there must be at least two census tracts or wards (i.e., enough neighborhoods for segregation to be measured) for that place-year to be observed.[10] Third, the place-year must have full covariate information. These sample restrictions ensure at least one point of comparison between pre and post HOLC within cities with measurable segregation indices (Lechner 2010). The number of cities and towns in the sample varies from year to year because of census reporting and small black populations in some cities. I observe 436 places in 1920 and 520 places in 1930. The 1940 complete count dataset includes information on 446 places for which pre-HOLC data are also available; 1950 and 1960 tract-level datasets include information on 100 and 252 places, respectively. I have NCDB and NHGIS time series data for 652 places between 1970 and 2010.[11]

Table 1 includes descriptive statistics of the analytic sample by year, as well as pooled across all years for which I have data and all places for which NHGIS provides data in 2010. On average, almost half of the city-years in my analytic sample were appraised by HOLC, although there is temporal variation in this measure—1950 and 1960 both have particularly high rates of appraisal, likely because census data for those two years are positively selected by population. This is an unfortunate limitation of the NHGIS datasets for 1950 and 1960 (i.e., the two decades between available full-count datasets and NCDB), which results in the smallest samples in those two years. Depending on measure, segregation peaked between 1950 and 1970. Compared to all census places in 2010, the sample is more segregated and is composed of cities with larger and blacker populations, on average. The sample is over-representative of cities and towns in the Northeast (36.2 percent of the 2010 sample), Midwest (35.4 percent), and South (22.2 percent), and the West is under-represented (6.1 percent)—this is reflective of the fact that there were few large cities in the West in 1930. In 2010, 64,503,768 people lived in cities and towns included in the analytic sample, representing approximately 20.9 percent of the United States population and 32.4 percent of the population that lived in census places in 2010. The 11,610,678 black people in these places represent approximately 53.0 percent of black people who lived in cities in 2010.

Estimating the Impact of HOLC Implementation on Segregation

I leverage a difference-in-differences (DID) framework to assess whether appraised cities experienced different segregation trajectories than unappraised cities in the decades after HOLC implementation. The intuition behind DID is that is allows for estimation of the difference in the before-to-after change in segregation between graded and ungraded cities (Angrist and Pischke 2008; Gelman and Hill 2007; Wooldridge 2012). Formally, the simplest version of my model is

$$\text{Segregation}_{it} = \alpha_0 + \lambda \text{HOLC}_i + \delta \text{Post-HOLC}_t + \tau\left(\text{HOLC}_i * \text{Post-HOLC}_{it}\right) + \varepsilon_i$$

where Segregation_{it} is a measure of segregation (e.g., black-white dissimilarity) for city i at time t, HOLC_i is an indicator variable coded 1 if a city was graded by HOLC appraisers and 0 if not, and Post-HOLC_t is an indicator for the time period after HOLC was passed (i.e., after 1930). I am primarily concerned with the coefficient on the interaction between these two indicator variables (i.e., τ), which is the DID estimator. If τ is positive, it suggests HOLC-appraised cities became more segregated after 1930 relative to the trends experienced by unappraised cities. The main effect coefficients are of some concern as well: λ indicates the pre-HOLC difference in segregation between graded and ungraded areas, and δ estimates the change in segregation after HOLC implementation among ungraded areas.

My analytic strategy proceeds in two main stages. The first involves estimating several modified versions of the equation described above within the full sample of 4,360 city-years. I add "pre-treatment" controls (i.e., 1930 measures of percent black, percent foreign-born, unemployment rate, population size, median home value, and the black-white homeownership ratio) as well as census division-specific time trends (i.e., division-by-year fixed effects). Although some statisticians suggest that adding post-treatment covariates threatens the ignorability assumption (Angrist and Pischke 2008; Gelman and Hill 2007), I next add time-variant sociodemographic characteristics (i.e., percent black, percent foreign-born, unemployment rate, population, and the black-white homeownership ratio) to assess whether changes in segregation may have been due to contemporaneous changes in the makeup of cities' residents, and to improve precision of the estimates (Wooldridge 2012). My next two models introduce city fixed effects with and without time-varying

Table 1. Descriptive Statistics for the Analytic Sample

	Analytic Sample										All Census Places in 2010
	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2010
Graded by HOLC	.46	.39	.40	.89	.70	.54	.46	.38	.36	.35	.13
	(.50)	(.49)	(.49)	(.31)	(.46)	(.50)	(.50)	(.49)	(.48)	(.48)	(.33)
Segregation Indices											
Dissimilarity	.39	.53	.46	.65	.64	.59	.50	.42	.35	.28	.11
	(.15)	(.21)	(.17)	(.18)	(.17)	(.18)	(.17)	(.17)	(.16)	(.15)	(.14)
Isolation	.14	.19	.19	.34	.34	.34	.30	.28	.27	.26	.14
	(.16)	(.19)	(.19)	(.26)	(.26)	(.27)	(.27)	(.26)	(.25)	(.24)	(.20)
Information Theory	.11	.21	.17	.37	.35	.31	.24	.18	.13	.09	.03
	(.08)	(.13)	(.12)	(.21)	(.20)	(.19)	(.17)	(.15)	(.13)	(.11)	(.06)
Covariates											
% Black	.09	.10	.10	.09	.11	.13	.14	.15	.17	.18	.11
	(.13)	(.13)	(.13)	(.08)	(.11)	(.13)	(.16)	(.17)	(.19)	(.19)	(.17)
% Foreign-Born	.13	.10	.08	.10	.25	.05	.06	.05	.08	.09	.10
	(.11)	(.09)	(.08)	(.06)	(.15)	(.05)	(.06)	(.07)	(.09)	(.10)	(.10)
Population	70,240	88,118	98,760	358,017	198,295	140,960	117,798	100,338	100,428	98,932	24,662
	(191526)	(370147)	(421383)	(911953)	(589036)	(464951)	(393209)	(373475)	(390367)	(389631)	(125811)
Black-White Homeownership Ratio[a]	.66	.71	.67	.67	.70	.71	.66	.60	.58	.54	.65
	(.27)	(.30)	(.32)	(.24)	(.22)	(.24)	(.21)	(.21)	(.16)	(.17)	(.35)
Observations	397	519	445	100	252	366	428	577	621	652	8,069

[a]Because NHGIS data do not distinguish between black homeowners and other non-white homeowners in 1950 or 1960, the homeownership ratio is calculated using the ownership rate among all non-white homeowners in these two decades.

controls, respectively. City fixed effects control for all time-invariant characteristics of each city (Allison 2009) (including pre-HOLC sociodemographic characteristics)—these models also include division-by-year fixed effects. All models include standard errors clustered at the city-level, which helps mitigate city-specific noise potentially caused by census geography problems. My preferred model includes division-by-year fixed effects as well as city fixed effects, but not contemporaneous controls, because sample attrition (Lechner, Rodriguez-Planas, and Kranz 2016) and post-treatment controls present ignorability concerns (e.g., post-treatment covariates could, themselves, have been affected by treatment condition) (Angrist and Pischke 2008; Gelman and Hill 2007).

The validity of this approach relies on an assumption that changes in segregation after 1930 would have been the same for graded and ungraded cities absent HOLC implementation (Gelman and Hill 2007). Visual inspection of the changes over time in the two decades preceding HOLC (and even, perhaps, in the first decade after HOLC) provides evidence in support of this "parallel trends" assumption (see Figure 1).[12]

Because HOLC appraisal was non-random (i.e., guidelines requested Residential Security Maps for cities with populations above 40,000), this initial approach faces an endogeneity concern. It is possible, for example, that larger cities before HOLC would have become more segregated over time than smaller cities before HOLC. Prior research shows that segregation tends to be higher in cities and metropolitan areas with larger populations (Rugh and Massey 2014)—especially larger black populations (Jargowsky 2018; Logan and Stults 2011)—presenting a potential source of confounding. Because the 40,000 population cutoff was not strictly enforced (i.e., there are 31 ungraded cities in my sample with populations above the cutoff and 118 graded cities below the cutoff), I am unable to leverage a regression discontinuity approach. However, the imperfection of this aspect of implementation provides another method through which to estimate HOLC's effect. The next stage of my analysis involves two approaches that restrict estimation of HOLC's impact to subsamples of cities that were very close to the population cutoff under the assumption that cities right above 40,000 would have otherwise experienced similar segregation trajectories as cities right below 40,000.

First, I draw from the distribution of city populations in 1930 to identify several samples of cities within which I estimate the DID model with city and division-by-year fixed effects (but not contemporaneous covariates). Specifically, I take the full sample of cities for which I have 1930 data and remove the smallest 1 percent and largest 1 percent in terms of population—this step produces more conservative results because it generates smaller population bands around the 40,000 cutoff. I then estimate the effects of HOLC on each measure of segregation among cities that had a 1930 population within one-tenth of a standard deviation of the 1930 population variable for remaining cities. I repeat this process among subsamples of cities drawn with ever larger population bands around the cutoff, up to one standard deviation.

In a second approach to deal with the fact that HOLC appraisal was largely driven by population size, I estimate DID models within a subsample of cities with 1930 populations larger than the smallest graded city (i.e., La Grange, IL, 1930 population: 10,111) and smaller than the largest ungraded city (i.e., Elizabeth, NJ, 1930 population: 114,607). I repeat this analysis within a series of samples between the second, third, fourth, fifth, and sixth largest ungraded and second, third, fourth, fifth, and sixth smallest graded cities—each time within a tighter population band. The intuition behind this analysis is another exploitation of the fact that the 40,000 cutoff was imperfect, and the cities within these subsamples were all at risk of being graded or ignored by HOLC.

The Stable Unit Value Assumption (SUTVA), which requires that change in segregation within any given city is unaffected by the HOLC appraisal status of other cities, presents another challenge to causal identification (Lechner 2010; Morgan and Winship 2014).

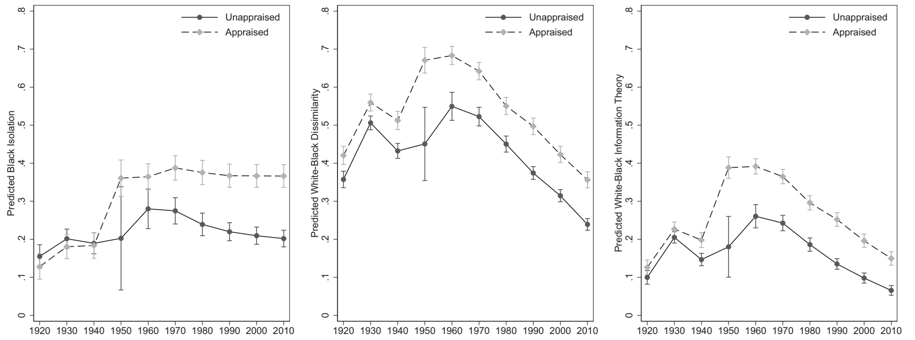

Figure 1. Average Dissimilarity, Isolation, and Information Theory Indices by Appraisal Status

We may expect, for example, that the effect of HOLC appraisals may shape segregation patterns within nearby, unappraised cities. I explore the possibility of proximity effects of appraisal by estimating differences in post-1930 segregation trends by distance to the nearest appraised city. Specifically, I create indicator variables for each decile of distance from an HOLC appraisal within a sample of cities within 100 kilometers of an HOLC appraisal measured between shapefile borders (i.e., cities reasonably close to appraisal to experience spillover). The first decile, for example, includes mostly appraised cities, but there are some cities outside of HOLC-covered areas—the average distance from an HOLC map is .1 km. The average distance from HOLC maps increases to 7.7 km in the second decile and up to 92.4 in the 10th decile. I next estimate each measure of segregation within post-1930 city-years as a function of each decile indicator variable,[13] division-by-year fixed effects, 1930 demographic characteristics, and 1930 measures of segregation. Each model includes place-level random effects and standard errors clustered at the place-level.

RESULTS

Differentiated Trajectories

Before HOLC, to-be-appraised cities had, on average, slightly higher black-white dissimilarity indices than unappraised cities (.559 compared to .501 among unappraised cities) and information theory indices (.227 compared to .205). Conversely, by 1930, black isolation was lower in to-be-appraised cities (.180) than in unappraised ones (.201).

Gaps between HOLC-appraised cities and cities HOLC ignored widened dramatically in the post-World War II period. Figure 1 shows predicted values from linear regressions of each segregation measure on an interaction between indicators for HOLC appraisal and year (i.e., the average of each index for each year by appraisal status with 95 percent confidence intervals). Both groups of cities experienced increases in segregation, although the rise was sharper among the appraised cities—especially along the dimension of black isolation. By 1950, black families in appraised cities were more isolated than black families in unappraised cities, although again, this difference was not significant. This gap gained significance in 1960 and remained significant through subsequent decades. By 2010, ungraded cities had a similar average black isolation index as they did in 1930 (.202), whereas black households in graded areas are far more isolated today (.366) than in 1930.

Complementary, although notably different, patterns emerge along black-white dissimilarity and information theory indices. Both indices rose in 1930, then fell by 1940—perhaps because of reliance on the 5 percent sample in 1930 (Logan et al. 2018; Reardon et al. 2018). The gap between appraised and unappraised cities grew slightly between 1930 and 1940, and then dramatically between 1940 and 1950.

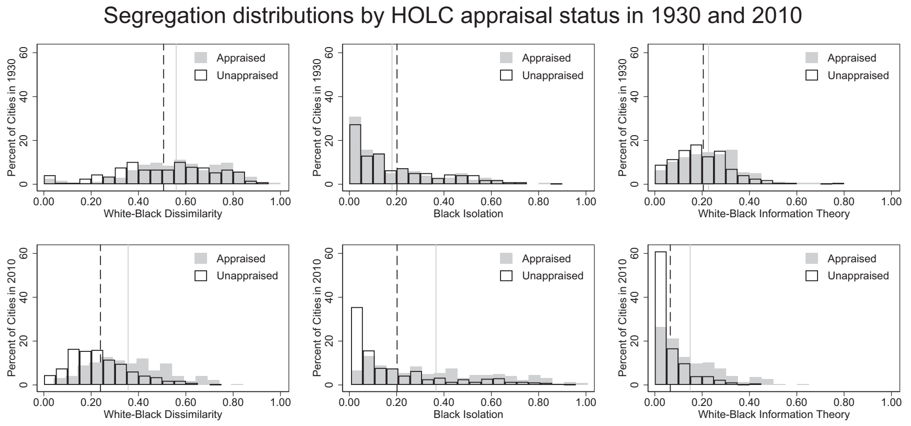

Figure 2. Distributions of Segregation Measures by Appraisal Status
Note: Vertical solid gray and dashed black lines indicate mean levels of segregation among appraised and unappraised cities, respectively.

In contrast to the stability of black isolation, both dissimilarity and information theory measures declined beginning around 1960 (for graded and ungraded areas). By 2010, dissimilarity fell to .356 and .239 for appraised and unappraised cities, respectively—both below their 1920 starting points. The black-white information theory index fell to .149 and .066 for graded and ungraded places, respectively—only slightly below their 1930 levels.

The gaps between appraised and ignored cities that emerged in the 1940s have not closed in the intervening six decades. In 2010, appraised cities had .117 higher dissimilarity, .084 higher information theory, and .164 higher isolation—all of which are statistically significant ($p < .001$) and substantively important. The isolation gap indicates that, compared to black residents of ungraded cities, black people in graded cities live in neighborhoods with a 16.4 percent higher black population share, on average. The difference in dissimilarity suggests that 11.7 percent more white households in appraised cities would need to move in order for there to be an equal distribution of white vis-à-vis black households in those cities. Along the measure of information theory, appraised cities were approximately as segregated in 2010 as unappraised cities were two decades earlier. Figure 2 provides another way to visualize differences in the long-term trajectories of cities based on appraisal by plotting the distributions of each measure of segregation by HOLC status for 1930 (top row) and 2010 (bottom row). Each plot overlays the appraised distribution (in gray bars) with the unappraised distribution (black outlined bars) and includes the average among appraised cities (solid gray line) and unappraised cities (dashed black line). In 1930, the distributions of each measure were quite similar across HOLC status—especially for black isolation. By 2010, however, large differences at the means emerged, but for slightly different reasons across measures. For white-black dissimilarity and information theory, 1930 to 2010 declines were larger among ungraded cities. For black isolation, there was effectively no change across 80 years among ungraded cities, whereas graded cities experienced a large increase.

The increase in segregation among ungraded areas from 1940 to 1960 is curious. One possible explanation for such a trend in the "untreated" group could be that the entire country was getting more segregated during this time period, which provides additional support for the use of DID techniques to evaluate the effect of HOLC (i.e., because DID estimates differential trends over time). Another possibility could be proximity effects of HOLC appraisal. For example, if HOLC affected segregation patterns via the

Table 2. Selected Results from Difference-in-Difference Estimates of HOLC Consequences within the Full Sample of Cities

	Model 1	Model 2	Model 3	Model 4	Model 5
	Outcome: Black-White Dissimilarity Index				
Post-1930	−.076***	−.178***	−.170***	−.181***	−.164***
	(.011)	(.040)	(.040)	(.039)	(.040)
Graded by HOLC	.049***	.029	.037*		
	(.014)	(.015)	(.015)		
Post-1930 and Graded by HOLC	.106***	.081***	.061***	.088***	.066***
	(.017)	(.016)	(.016)	(.016)	(.016)
	Outcome: Black Isolation Index				
Post-1930	.036***	−.099***	−.036***	−.105***	−.051***
	(.009)	(.014)	(.009)	(.015)	(.009)
Graded by HOLC	−.026	−.004	.016*		
	(.015)	(.009)	(.007)		
Post-1930 and Graded by HOLC	.156***	.132***	.053***	.137***	.067***
	(.015)	(.014)	(.008)	(.014)	(.008)
	Outcome: Black-White Information Theory Index				
Post-1930	−.028***	−.122***	−.109***	−.130***	−.116***
	(.007)	(.017)	(.017)	(.017)	(.017)
Graded by HOLC	.017*	.010	.018		
	(.009)	(.010)	(.010)		
Post-1930 and Graded by HOLC	.115***	.089***	.067***	.100***	.080***
	(.012)	(.011)	(.011)	(.011)	(.011)
Observations	4,357	4,357	4,357	4,357	4,357
1930 Characteristics	No	Yes	Yes	No	No
Contemporaneous Characteristics	No	No	Yes	No	Yes
Division-by-Year Fixed Effects	No	Yes	Yes	Yes	Yes
City Fixed Effects	No	No	No	Yes	Yes

Note: Standard errors are clustered at the city-level.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tests).

mechanism of inter-city migration, appraisal of a city may also have increased the segregation of nearby cities. If so, this would bias estimates of the direct effect of HOLC toward zero, as nearby, ungraded cities would also have experienced an increase in segregation over time. However, as I will show, I do not find strong evidence in support of proximity effects. Therefore, it is more likely there was a secular trend toward more segregated cities in the middle of the twentieth century.

Estimating Redlining's Impact

I next explore the gap in segregation between graded and ignored cities in a difference-in-difference framework. Table 2 displays selected results[14] from a series of models predicting black-white dissimilarity (in the first panel), black isolation (second panel), and black-white information theory (third panel) as functions of HOLC appraisal. The unit of observation is the place-year. The intuition behind these models is that they identify differences in pre-to-post-HOLC changes in segregation between graded and ungraded cities. The primary variable of interest is the interaction between the indicator variables identifying the post-1930 time period and HOLC grading (i.e., the DID estimator), which is the average pre-to-post difference across all post-1930 place-years. Coefficients for the *post-1930* variable indicate the average difference in segregation between the pre- and post-HOLC periods among ungraded cities (net of covariates in some models), and coefficients on the *graded by HOLC* variable measure the average difference in segregation between appraised and unappraised cities before HOLC.

Starting with the first panel, which estimates changes in black-white dissimilarity, Model 1 shows that, on average, this measure of segregation was approximately .076 lower in the years following HOLC implementation within ungraded cities (i.e., the coefficient on *post-1930*). Graded cities, however, experienced a .106 increase in dissimilarity relative to ungraded cities (i.e., the coefficient on the interaction between *post-1930* and *graded by HOLC*). The post-HOLC gap between graded and ungraded cities remains significant even after adding division-by-year fixed effects and pre-HOLC characteristics (Model 2), contemporaneous covariates (Model 3), and city fixed effects[15] (Models 4 and 5). Although controlling for post-treatment characteristics threatens the ignorability assumption (Angrist and Pischke 2008; Gelman and Hill 2007), these results suggest sociodemographic changes within cities in the years after HOLC, which may have been due to HOLC, do not fully explain the differential segregation trajectories of graded and ungraded cities.

A similar pattern emerges in the next two panels, which estimate change in black isolation and black-white information theory indices, respectively. On average, HOLC-graded cities experienced a .156 larger change in isolation and a .115 larger change in the information theory index relative to concurrent segregation changes within ungraded cities. These gaps retained significance across all five models. The negative *post-1930* coefficient in models of the information theory index reflect the patterns in Figure 1, which show a decline (on average) in this measure after 1960. The inconsistent signs on the *post-1930* coefficient in models of black isolation reflect the relative lack of change in this measure across the nine decades in the sample.

So far, the results show that, on average, HOLC-graded cities and towns became significantly more segregated than ungraded places in the same division-year, with similar contemporaneous characteristics and 1930 characteristics.[16] The magnitudes of these results are quite large. For example, the .088 coefficient in the preferred model (Model 3) of black-white dissimilarity is more than one third of the average dissimilarity among unappraised cities in 2010 and equivalent to approximately one quarter of the 60-year change between dissimilarity's 1950 peak (.65) and the end of the period (.28).

I next leverage the DID framework to explore whether the gap between graded and ungraded cities varied over the implementation period (e.g., if any effect of HOLC declined over time) (Autor 2003). Specifically, I estimate models predicting each measure of segregation as a function of an interaction between the DID estimator and dummy variables for each year (with 1930 left out as the reference category). All models include city fixed effects and standard errors clustered at the city-level, but they exclude post-treatment controls. This empirical approach is similar to "event studies" used for causal identification in longitudinal settings (Wooldridge 2012). The coefficients for the interaction terms (plotted in Figure 3) do not suggest an increase or decrease in the gap between graded and ungraded areas in black isolation or black-white dissimilarity, which were cemented in place by 1950. However, there is evidence that the information theory disparity declined over time—although it remained significant in every individual year after 1950.

Exploiting Imperfect Implementation of HOLC Appraisal Assignment and Geographic Spillover

I next estimate the effect of HOLC within a series of subsamples of cities that were close to the 40,000 population cutoff before implementation (i.e., in 1930). This stage of analysis is premised on the assumption that cities right above 40,000 would have otherwise experienced similar segregation trajectories as cities right below 40,000 were it not for redlining. Table 3 displays DID estimators for a series of models within increasingly large

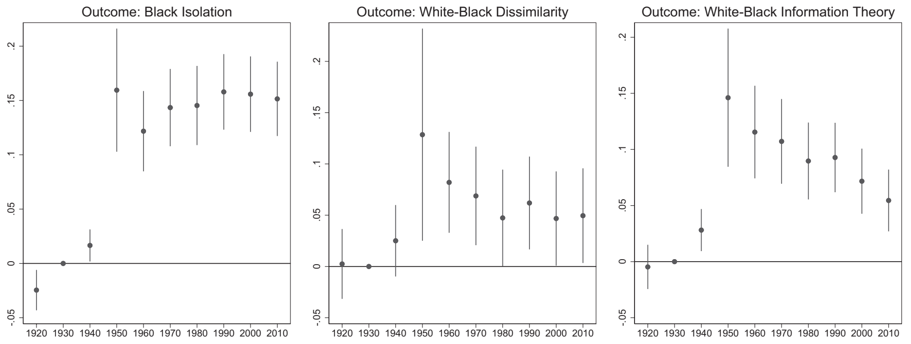

Figure 3. Change in Difference-in-Differences Magnitude Over Time

population bands around the cutoff—all models include city fixed effects, division-by-year fixed effects, and an indicator for post-1930, but not contemporaneous sociodemographic controls. The bottom two rows show the 1930 populations of the smallest and largest cities in each sample. The first column displays results within the smallest subsample (i.e., cities with populations between one-tenth of a standard deviation below and one-tenth of a standard deviation[17] above 40,000). The smallest city in this subsample of 671 city-years, Middletown, OH, had a population of 29,992 in 1930, and the largest, Pittsfield, MA, had a population of 49,701. Although point estimates for the DID estimator of the effect of HOLC on dissimilarity (the first row), isolation (second row), and information theory (third row) are all positive, they lack precision. Estimates of HOLC's effect on all three segregation indices are significant in the second-smallest population band (i.e., .2 standard deviations above and below 40,000) and remain significant through all subsamples, with relatively stable magnitudes.

Before HOLC (i.e., in 1930), dissimilarity, isolation, and information theory differences between graded and ungraded cities were statistically indistinguishable. Appraised cities experienced changes in black-white dissimilarity that were between .053 and .063 larger than unappraised cities, depending on population band. Estimates of HOLC's effect on the black isolation and black-white information theory indices range from .071 to .090 and .058 to .067, respectively. Note that the smallest city in the full sample, Bristol, VA, is within .4 standard deviations of 40,000, so ever-larger population bands only add cities with populations above the cutoff. Importantly, point estimates do not substantively change between the .4 standard deviation population band and wider bands, suggesting this is not a source of bias for this approach.

In another approach to deal with the fact that HOLC appraisal was largely driven by population size, I estimate DID models within a subsample of cities with 1930 populations larger than the smallest graded city (i.e., La Grange, IL, 1930 population: 10,111) and smaller than the largest ungraded city (i.e., Elizabeth, NJ, 1930 population: 114,607)—and then again within a series of subsamples between increasingly small population bands between the second, third, fourth, fifth, and sixth smallest graded and largest graded cities.

These results, presented in Table 4, again support the argument that HOLC increased the segregation of cities it appraised. The first column includes cities with 1930 populations between the smallest graded and largest ungraded cities, and the next five columns estimate HOLC's effect within smaller samples. The DID estimators in models of each of the three segregation indices are positive, significant, and stable in magnitude even within subsamples below these cities' populations and above the fifth and sixth smallest graded cities. Again, pre-HOLC segregation differences between graded and ungraded cities were not significant in the smallest subsample (i.e., cities with 1930 populations

Table 3. Selected Results from Difference-in-Difference Estimates of HOLC Consequences among Cities with pre-HOLC Populations Near the 40,000 Population Cutoff for Appraisal

	Outcome: Black-White Dissimilarity Index									
Post-1930 and Graded by HOLC	.031	.063*	.059**	.055**	.054**	.053**	.055**	.056**	.057***	.061***
	(.041)	(.025)	(.020)	(.019)	(.019)	(.019)	(.018)	(.017)	(.017)	(.017)
	Outcome: Black Isolation Index									
Post-1930 and Graded by HOLC	.016	.071**	.079***	.076***	.076***	.077***	.084***	.086***	.088***	.090***
	(.039)	(.021)	(.018)	(.016)	(.016)	(.016)	(.015)	(.015)	(.015)	(.015)
	Outcome: Black-White Information Theory Index									
Post-1930 and Graded by HOLC	.022	.064***	.060***	.059***	.058***	.058***	.062***	.064***	.065***	.067***
	(.023)	(.016)	(.013)	(.012)	(.012)	(.012)	(.011)	(.011)	(.011)	(.011)
Observations	671	1,615	3,379	3,505	3,575	3,614	3,742	3,844	3,890	3919
Width of Population Band	.1 SD	.2 SD	.3 SD	.4 SD	.5 SD	.6 SD	.7 SD	.8 SD	.9 SD	1 SD
Minimum 1930 Population in Subsample	29,992	19,900	10,038	8,841	8,841	8,841	8,841	8,841	8,841	8,841
Maximum 1930 Population in Subsample	49,701	60,009	68,790	79,338	86,642	100,295	107,003	119,799	129,326	140,241

Note: All models include indicator variables for post-1930 and graded by HOLC as well as city fixed effects and division-by-year fixed effects. Standard errors are clustered at the city-level.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tests).

Table 4. Selected Results from Difference-in-Difference Estimates of HOLC Consequences within Subsamples between the Smallest Graded and Largest Ungraded Cities

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Outcome: Black-White Dissimilarity Index					
Post-1930 and Graded by HOLC	.051**	.055**	.057**	.059**	.065**	.062**
	(.018)	(.018)	(.019)	(.020)	(.021)	(.021)
	Outcome: Black Isolation Index					
Post-1930 and Graded by HOLC	.084***	.086***	.084***	.080***	.080***	.079***
	(.015)	(.015)	(.016)	(.016)	(.018)	(.018)
	Outcome: Black-White Information Theory Index					
Post-1930 and Graded by HOLC	.061***	.062***	.060***	.060***	.061***	.060***
	(.011)	(.012)	(.012)	(.013)	(.013)	(.014)
Observations	3,748	3,611	3,420	3,195	2,972	2,844
Minimum 1930 Population in Subsample	10,111	10,253	10,258	11,098	11,255	11,584
Maximum 1930 Population in Subsample	114,607	104,863	81,753	77,191	64,126	62,347

Note: Model 1 includes cities with 1930 populations between the smallest graded and largest ungraded cities, Model 2 includes cities between the second largest ungraded and second smallest ungraded cities, up to Model 6, which includes cities between the sixth smallest graded and sixth largest ungraded cities. All models include indicator variables for post-1940 and graded by HOLC as well as city fixed effects and division-by-year fixed effects. Standard errors are clustered at the city-level.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tests).

between the sixth smallest graded city and the sixth largest ungraded city). The range of DID coefficient magnitudes for isolation and information theory indices are similar to those found in the population band analysis (Table 3), and the DID estimators in models of dissimilarity are slightly larger here. In general, results from both subsample analyses suggest a slightly weaker—although still significant—effect of HOLC on segregation than do the full sample results (Table 2).

To explore whether the effects of HOLC appraisal may have spilled over to nearby cities, I estimate post-1930 segregation as a function of distance to the nearest HOLC map among a subsample of cities within 100 kilometers of an appraisal. Models also include diviion-by-year fixed effects, 1930 demographic characteristics, 1930 measures of segregation, place-level random effects, and standard errors clustered at the place-level. Figure 4 shows marginal effects from these models, which provide little—if any—evidence for a spillover effect of HOLC. Differences in predicted segregation are statistically indistinguishable for all distances but the 10th decile (i.e., cities approximately 81 kilometers from an HOLC-graded area). Specifically, when the second decile is used as the reference category, negative and significant coefficients are estimated for the indicator variables for 9th and 10th deciles (i.e., cities in the two farthest deciles became significantly less segregated than cities in the second decile net of controls). When the third decile is the reference category, only coefficients for the 10th decile are significant. The lack of strong evidence for a proximity effect supports my empirical decision to measure HOLC's reach as binary. This city-level finding (i.e., what seems to matter most is simply whether HOLC touched a city or town) also reflects prior research highlighting municipal borders as crucial sites of racial segregation (Bischoff 2008; Lichter et al. 2015; Massey, Rothwell, and Domina 2009).

Exploring Possible Mechanisms

As discussed in detail earlier, data limitations preclude a robust analysis of the mechanisms responsible for HOLC's segregationist effect

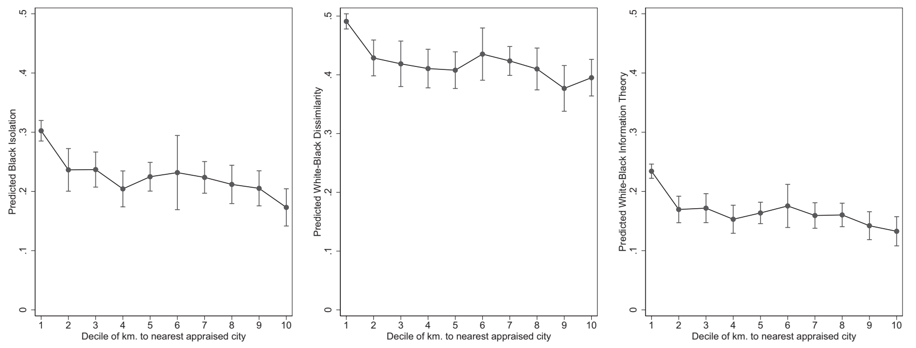

Figure 4. Predicted Segregation by Distance to Nearest HOLC-Appraised City

on appraised cities (e.g., there are no reliable data tracking racial preferences over time within places). One possible mechanism for which reliable data exist is shifting racial populations. It is possible, for example, that neighborhood appraisals served as a signal to mobile white families that racialized geographic advantage would be secured via redlining (i.e., government-enforced racial boundaries would preserve the color line). Conversely, redlining may have signaled that a city had a non-trivial black or immigrant population, which persuaded white, native-born households to move away from that city. The structure of HOLC appraisals also created financial incentives for white households to suburbanize (Jackson 1985). Because shifting flows of white and black populations reacting to HOLC implementation could shape segregation patterns, I estimate several models of city demographic makeup as a function of HOLC grading. Specifically, I estimate the preferred DID model with city and division-by-year fixed effects and without contemporaneous covariates within the full sample of all cities for which I have data, along with a restricted sample, which only includes cities with 1930 populations within .2 standard deviations of the 40,000 population cutoff (i.e., the smallest subsample of cities in which I see a significant relationship between HOLC implementation and segregation).

Table 5 displays the DID estimator from a series of models of four demographic characteristics: total population, white population, black population, and percent black. Results in the first two columns suggest that cities graded by HOLC experienced larger population increases after 1930 relative to ungraded cities—within the full and the restricted samples. Estimates of HOLC's effect on white populations are noisy and change signs between the full and restricted samples (third and fourth columns), and the fifth and sixth columns indicate that black populations grew significantly faster in graded cities. Within the full sample, this led to a concurrent, significant increase in black population share (column seven), although black share in appraised cities was statistically indistinguishable from unappraised cities within the restricted sample (column eight).

These supplemental models provide some evidence that inter-city migration may have been shaped by the distribution of HOLC appraisal, however Models 3 and 5 in Table 2 show a relationship between HOLC and segregation net of changes in place racial makeup. Another potential mechanism connecting appraisal to segregation is racialized sorting within cities due to HOLC. For example, neighborhood ratings may have made it more difficult for both black and white households to cross the color line due to the financial disincentives of integration created by HOLC. This phenomenon—and its role in shaping the patterns documented earlier—is difficult to estimate given the data on hand. However, Aaronson and colleagues (2018) show HOLC likely hardened racial borders

Table 5. Possible Mechanisms

Outcome	Total Population		White Population		Black Population		Percent Black	
Sample	Full	Restricted	Full	Restricted	Full	Restricted	Full	Restricted
Post-1930 and Graded by HOLC	41406.837***	21440.496**	−9787.545	11889.724	36424.132***	6440.769***	.058***	.027
	(10250.255)	(8155.492)	(11655.140)	(6238.690)	(6768.193)	(1804.498)	(.010)	(.017)
Observations	4,357	1,615	4,357	1,615	4,357	1,615	4,357	1,615

Note: Restricted samples include cities with 1930 populations within .2 standard deviations of the 40,000 population cutoff. All models include indicator variables for post-1930 and graded by HOLC as well as city fixed effects and division-by-year fixed effects. Standard errors are clustered at the city-level.
*$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed tests).

Table 6. Selected Results from Estimates of HOLC Consequences Including Region Interactions

	Dis-similarity	Isolation	Information Theory	Dis-similarity	Isolation	Information Theory
Post-1930	−.077*** (.022)	−.064*** (.016)	−.076*** (.017)	−.181*** (.040)	−.116*** (.017)	−.128*** (.017)
Post-1930 and Graded by HOLC	.090** (.030)	.096*** (.024)	.106*** (.024)	.087*** (.018)	.151*** (.017)	.097*** (.012)
Post-1930 and Graded by HOLC × Northeast	−.089 (.048)	−.029 (.026)	−.033 (.026)			
Post-1930 and Graded by HOLC × Midwest	−.047 (.037)	−.034 (.025)	−.033 (.025)			
Post-1930 and Graded by HOLC × West	−.093 (.069)	.014 (.065)	−.025 (.051)			
Post-1930 × Northeast	−.022 (.041)	.024 (.033)	−.033 (.030)			
Post-1930 × Midwest	.012 (.040)	.092* (.036)	.018 (.030)			
Post-1930 × West	.031 (.079)	−.017 (.046)	−.033 (.044)			
Post-1930 and Graded by HOLC × South				.104* (.045)	.052* (.024)	.052* (.025)
Post-1930 × South				.003 (.035)	−.055 (.030)	.009 (.027)
Observations	4,357	4,357	4,357	4,357	4,357	4,357

Note: All models include city fixed effects and division-by-year fixed effects. Standard errors are clustered at the city-level.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$ (two-tailed tests).

between neighborhoods within cities. The most likely scenario is HOLC shaped both inter- and intra-city sorting, resulting in differentiated segregation trends between graded and ungraded places.

Regional variation may also shed light on potential mechanisms. For example, many southern legislators resisted New Deal programs and insisted that any provision exclude African Americans (Katznelson 2005, 2013; Rothstein 2017). The South was also slow to adopt fair housing legislation (Collins 2006). This racialized political economy of housing may have exacerbated the effects of HOLC implementation. I investigate this possibility by estimating difference-in-difference-in-differences models (triple differences) in which region is interacted with HOLC appraisal status and post-treatment timing.

Table 6 displays selected results from these three-way interacted models, which include city fixed effects and division-specific time trends. The primary coefficients of concern are the interactions between the original DID estimator (i.e., the interaction between HOLC graded and post-1930) and regional indicators, which measure difference across regions in the impact of HOLC. The first three columns generally show imprecise (although generally negative) interactions with non-South indicators. Because this imprecision may be due to statistical power lost through disaggregation (e.g., there are only 255 city-years in the West), I next compare the South to the rest of the country. The latter three columns do show significant, negative coefficients on the interaction between South, HOLC graded, and post-1930, suggesting HOLC had a stronger effect in the South compared to cities in the rest of the country.

The magnitude of this heterogeneity is striking: the interaction's coefficient in the model of dissimilarity (.104) is larger than what we may consider the main effect of HOLC in the rest of the country (.87). In other words, HOLC may have had more than twice as large an effect on black-white dissimilarity in the South. The interaction terms in models of isolation (.052) and information theory (.52) were approximately one third and one half the size of the main effects, respectively—again marking substantial regional differences. Identifying the specific reasons why HOLC had more of an effect in the South is beyond the scope of this article, but this regional variation suggests a path forward for such an analysis, which I detail further below.

Counterfactual Histories

I use the results above to explore two counterfactuals: one in which the federal government did not contribute billions of dollars toward a segregationist project, and a more radical version of history involving housing policies with explicitly anti-racist, *integrationist* goals.

The first scenario considers what would have happened to cities without HOLC or subsequent housing policies. In 1920 and 1930, to-be-appraised and unappraised cities had substantively similar levels of segregation; this project relies on the assumption that they would have continued on parallel paths absent federal intervention. My primary argument here is that had the color line not been granted federal backing and encouragement, the national rise in segregation during the middle of the twentieth century would have been less severe because the average dissimilarity, isolation, and information theory indices would be .088, .137, and .1 lower in appraised cities (i.e., the DID estimators in models with city fixed effects), respectively. For example, average white-black dissimilarity among appraised cities would have peaked at .60 in 1960, rather than .68. By 2010, dissimilarity would fall to .27 among these cities (rather than .36). These drops among appraised cities would have pulled down average dissimilarity within the entire analytic sample from .64 to .58 in 1960 and from .28 to .25 in 2010.

The more radical counterfactual—housing policies with integrationist goals—is also worth considering. If HOLC, FHA, and the GI Bill encouraged integration, what might cities and towns in the United States look like? For example, rather than subtracting the effect of HOLC from appraised cities, we can subtract 150 percent of the effect to estimate how an anti-racist housing policy could have shaped segregation patterns. This scalar is arbitrary but assumes that an effort to integrate neighborhoods would be half as effective as federal policies were at segregating neighborhoods. In this counterfactual, average dissimilarity, isolation, and information theory indices would be .132, .206, and .15 lower in appraised cities, respectively. This integrationist effect would have led to 1960 dissimilarity, isolation, and information theory indices of .55, .23, and .25, respectively.

Another method through which to evaluate these alternative histories is to estimate how many fewer highly segregated cities would exist in each scenario. Previous work has established definitions of "hypersegregation" for metropolitan areas (Massey and Denton 1989; Massey and Tannen 2015), but my analysis of cities and towns requires a different definition because segregation measures tend to be much lower for smaller units of geography. I define "highly segregated" as being above the 75th percentile of the distributions of each segregation measure among unappraised cities in 1960. These values are .68, .39, and .48 for dissimilarity, information theory, and isolation, respectively. Therefore, to qualify, a city must be more segregated than the large majority of cities unappraised by HOLC at the peak of segregation. This leads to conservative counts of highly segregated cities, although the results are substantively similar using alternative techniques.

Figure 5 displays the number of highly segregated, HOLC-appraised cities by decade

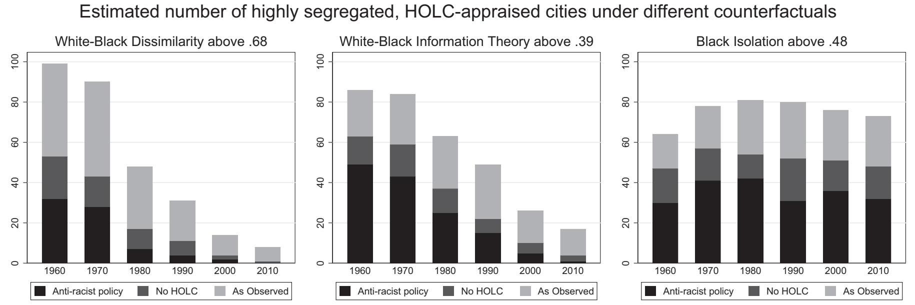

Figure 5. Counterfactual Estimates of Highly Segregated Cities
Note: The cutoff for "highly segregated" is the 75th percentile of the distribution of each segregation measure drawn from ungraded cities in 1960. "Anti-racist" policy is the count of HOLC-graded cities above this cutoff in each year assuming HOLC had an integrationist effect. "No HOLC" is the count of cities above this cutoff assuming HOLC was not implemented. "As observed" is the actual count of cities observed as above "highly segregated" in the analytic sample.

(focusing on post-peak decades), with each measure, and under each counterfactual. For example, the first column of the first panel shows that a total of 99 appraised cities (home to 6,798,336 black people) had a dissimilarity index above .68 in 1960 (i.e., the sum of the black, dark gray, and light gray bars). Under the "no HOLC" counterfactual, in which the estimated effect of HOLC is subtracted from appraised cities, the number of cities that qualify as highly segregated drops by almost half to 53 (i.e., the sum of the black and dark gray bars)—4,571,114 black people lived in these cities. Finally, under the "anti-racist policy" counterfactual, in which 150 percent of the estimated effect of HOLC is subtracted from appraised cities, only 32 cities (home to 2,963,090 black people) have dissimilarity indices above .68 (i.e., the black bar). Absent HOLC, approximately two million fewer African Americans would have lived in highly segregated cities in 1960. An anti-racist, integrationist housing policy could have lowered this number by over 1.5 million further.

As average dissimilarity declined from 1960 to 2010, the number of cities with an index above .68 fell dramatically under each scenario. At the end of the period of study, only eight cities (with 4,997,991 black residents) were highly segregated based on this measure. Without HOLC, only one city (Chicago, IL) would still have a dissimilarity index above .68. No cities qualify under the anti-racist condition. A similar pattern emerges with the white-black information theory index, although more cities remain highly segregated under the counterfactual scenarios using this measure. By 2010, 17 appraised cities have an information theory index above .39, and only four would without HOLC. In the anti-racist hypothetical, only one city would remain highly segregated—Chicago.

The trends are different, but complimentary, when looking at black isolation. As shown in Figure 1, this segregation measure rose and then stabilized among appraised and unappraised cities. Still, the number of cities with high levels of black isolation (i.e., above .48), would be substantially lower under either counterfactual scenario. In 2010, 73 appraised cities have a higher isolation index than .48—home to 10,851,586 African Americans. Without HOLC, only 8,937,039 black households in 48 cities would experience this level of segregation and 7,533,553 across 32 cities under the anti-racist condition.

Of course, these hypothetical scenarios offer simplified versions of the change in U.S. racial geography over the latter half of the twentieth century. Countless government policies, institutional practices, and sociopolitical dynamics also shaped segregation patterns. This is precisely why federal investment in segregation through massive housing programs in the first half of the century carries such importance. This counterfactual exercise may be an underestimate of how segregation patterns (and racial inequality more broadly) would have evolved given the cascading effects of residential segregation on other aspects of social and economic life. Had a "white noose" of suburban affluence not emerged around the black ghetto (Rothstein 2017:201), racial differences in educational attainment (Reardon et al. 2019; Reardon and Owens 2014; Wodtke et al. 2011), wealth accumulation (Conley 1999; Desmond 2017; Flippen 2004; Oliver and Shapiro 2006), and politics (Ananat and Washington 2009) may not have been as severe and may not have provided segregation the "momentum" it continues to have (Krysan and Crowder 2017).

DISCUSSION

This article explored differences in segregation trends between cities and towns that were appraised by the Home Owner's Loan Corporation (HOLC) and those that were ignored by this policy. I show—across a wide range of modeling techniques—that appraised places became and remained far more segregated in the decades after HOLC implementation. The gap between these two groups of cities emerged during the 1940s—when HOLC's racist practices were adopted by and expanded via the much larger FHA and GI Bill (Jackson 1985)—and remained remarkably stable over a long period of time. In 2010, more than seven decades after HOLC implementation, the average white-black dissimilarity, black isolation, and black-white information theory indices were 12, 16, and 8 points higher, respectively, in places appraised by this policy (net of place and division-by-year fixed effects).

These findings corroborate claims that New Deal housing policies had enormous effects on racial geography in the United States by encouraging segregation through the drawing and grading of neighborhoods (Dreier et al. 2005; Hirsch 1983; Jackson 1985; Krysan and Crowder 2017; Logan 2016; Massey and Denton 1993; Quinn 2019; Roediger 2006). Although it should come as no surprise that government investment of this scale could have a dramatic and lasting effect, no previous work has attempted to measure the enduring consequences of this suite of federal policies. The New Deal heavily subsidized the segregation of white people and capital from black people, establishing the sociospatial arrangement of goods and services (e.g., jobs and schools) that, in the postwar United States, ensure "geography is destiny" (Sugrue 1996:xl). Racialized places provide opportunities for white families' upward mobility (Lipsitz 2011) and the disproportionate immobility of disadvantaged black families (Sharkey 2008, 2013).

Results suggest little weakening over time of the effect of HOLC appraisal despite substantial social and economic changes in the intervening decades—only along the dimension of white-black information theory does the effect appear to be diminishing. Perhaps this is evidence that HOLC is deeply connected to other historical processes, which further shaped housing opportunity in racialized ways. The FHA and GI Bill made even larger investments in housing and generally adopted HOLC guidelines (Jackson 1985). Private appraisers continued the segregationist practices of these New Deal programs decades after they were phased out or abandoned explicitly racist guidelines (Thurston 2018). Urban renewal in the late twentieth century displaced hundreds of thousands of residents from cities across the country, disproportionately affecting black communities and previously redlined communities (Massey and Denton 1993; Nelson and Ayers 2019). Decades of exclusion from mortgage credit also made communities of color vulnerable to exploitation via severely constrained rental markets (Connolly 2014).

The long-term stability of HOLC's effects also helps inform contemporary theoretical discussions about the causes and persistence of racial segregation. This pattern of results strongly supports the argument that the general outlines of racial geography in the United States put in place during the mid-twentieth century present an obstacle to change in and of themselves (Logan 2016). My findings are wholly consistent with Krysan and Crowder's (2017) structural sorting perspective as well as the broader historical record of U.S. housing policies. However, my results extend Krysan and Crowder's idea of "momentum," conceptualized primarily at the individual-level, to governments and institutions. HOLC's segregationist logic carried "momentum" through subsequent federal and local policies as well as private institutions (e.g., mortgage lenders). This inheritance facilitated and encouraged highly racialized mobility patterns, which "shape and are shaped by segregation in ways that have essentially allowed segregation to become self-perpetuating" (Krysan and Crowder 2017:252). Thus, HOLC was a strong institutional intervention not solely because of scale and resources, but because of legacy—institutionalizing social categories (i.e., racialized neighborhoods) created a "durable inequality" (Tilly 1998). This contribution also builds on related literature documenting persistent effects of institutional legacies on racial segregation (e.g., the long reach of slavery [Grigoryeva and Ruef 2015; O'Connell, Curtis, and DeWaard 2020]).

This project has several limitations, the most important of which is the fact that HOLC appraisal was not randomly assigned. City population is positively correlated with each measure of segregation in my sample (dissimilarity: .22; isolation: .23; information theory: .30) and HOLC appraisal was designed to select on population. I leverage imperfect implementation of appraisal guidelines to help negotiate this endogeneity concern. Specifically, 118 cities with 1930 populations below the 40,000 cutoff were appraised, and 31 cities above the cutoff were not appraised. There is strong evidence of HOLC's effect within a subsample of cities with populations above the smallest appraised city and below the largest unappraised city. I further document an HOLC effect within even smaller subsamples of cities much closer to 40,000 (i.e., those with 1930 populations within .2 standard deviations of the cutoff) and within a subsample of cities entirely below 40,000 (i.e., those with 1930 populations below the fifth largest ungraded city and above the fifth smallest graded city). Importantly, pre-HOLC segregation differences between graded and ungraded cities within these subsamples were not statistically significant. Although these steps do not completely correct the endogeneity concern, they do show that the relationship between HOLC implementation and segregation is not driven solely by comparison of very large cities to very small cities.

Changes in census geography pose another limitation. Place and neighborhood boundaries change over time (until 1970, after which there are consistent tract boundaries), which may confound what I estimated to be an effect of HOLC on segregation. I restrict the geographic definition of each place to one year (i.e., 2012) to help address changing city and town boundaries. Doing so results in calculating segregation within a consistent geography, but it risks masking the ways municipal boundaries have shifted over time since HOLC implementation—especially in light of evidence documenting the growing importance of municipal boundaries for understanding segregation (Lichter et al. 2015; Massey et al. 2009). Considering the long history of communities drawing municipal boundaries to exclude African Americans, a practice that accelerated through the twentieth century (de Souza Briggs 2007; Lipsitz 2011; Tyson 2014), it is likely that my imposed boundary consistency led to lower estimates of HOLC's effect on segregation.

I also conducted multiple robustness checks of the validity of my approach to calculating segregation (discussed in detail in the Methods section). For changing tract boundaries to threaten my findings, segregation-bias in tract boundary definitions would have to be correlated with HOLC appraisal net of city fixed effects and division-by-year fixed effects (as well as 1930 and contemporaneous controls in alternative models). Reliance on a limited, 5 percent sample for 1930 may also be a concern. Consistent with prior research showing that smaller samples tend to result in higher measures of segregation (Logan et al. 2018; Reardon et al. 2018), I do observe slight increases in segregation from 1920 to 1930 followed by decreases in 1940. Because this potential upward bias in segregation measurement is pre-treatment, my estimates of HOLC's effect are likely downwardly biased (i.e., I am understating the HOLC's effect).

The phenomena of white flight and suburbanization are also not well-captured here because of conservative sampling. This is due, in part, to the fact that many suburban subdivisions constructed in the post-World War II period did not exist in 1930 (Rothstein 2017; Taylor 2019), so they are not in the analytic sample. This sampling restriction likely biases the results toward the null hypothesis (i.e., there was no effect of HOLC), because some predominantly-white (and exclusively white [Loewen 2005; Sugrue 1996]) suburban communities are not included in the unappraised group of cities. Indeed, I find a much stronger relationship between HOLC and segregation when I loosen sampling requirements (see Table S6 in the online supplement). Because of this, any effect HOLC may have had on segregation measured among larger geographic units (e.g., metropolitan areas) may have been even more severe, because of the additional dynamic of inter-city segregation.

The specific mechanisms through which HOLC implementation increased segregation warrant further study. Although I present evidence suggesting HOLC affected racialized migration across cities, I still find a significant and positive relationship between appraisal and segregation net of changing city racial makeup (i.e., in Models 3 and 5 in Table 2). HOLC neighborhood boundaries likely also shaped intra-city migration in a racialized manner (Aaronson et al. 2018), which would have contributed to the segregationist effect of the policy. More work should be done to explore the comparative effects of these and other mechanisms. Qualitative analyses of neighborhood area descriptions written by HOLC appraisers could also provide insight into how real estate speculation, displacement, and disinvestment fueled segregation, as well as provide nuanced understanding of heterogeneity across cities.

I find important regional heterogeneity in HOLC's effect. Appraisals of southern cities had twice as large an effect on black-white dissimilarity, as well as much larger effects on isolation and information theory indices, compared to the rest of the country. These differences point in several directions for additional research on the specific mechanisms responsible for HOLC's effects. This manuscript is focused on housing, so the South's politics of resistance to racial progressivity in New Deal policies (Katznelson 2005, 2013; Rothstein 2017) and fair housing legislation (Collins 2006) come to mind. However, numerous structural differences across regions could have exacerbated HOLC's segregationist effect, such as the built environment (Logan and Martinez 2018), school desegregation (Johnson 2019), and local zoning (Silver 1991).

Local community organizing may have also played and may continue to play a role in differentiating HOLC-graded places from those the policy ignored—through housing and development policy or collective responses to discrimination and segregation. Social historians have long documented the power of local politics in shaping the color line to isolate African Americans (Hirsch 1983; Loewen 2005; Sugrue 1996). Connecting the geography of HOLC appraisal to changes in political attitudes or housing policy—especially in the post-Civil Rights Era, when segregation began to fall in many areas—could be a rich area for additional research.

Despite limitations, these findings carry important implications for our understanding of the effect of public policy on the permanence of spatial inequality. In many ways, racial geography in the United States changed dramatically between 1930 and 2010 (Cutler et al. 1999). However, the hierarchy of places along dimensions of racial residential segregation was established (or exacerbated) by New Deal housing policies and has been effectively stable since 1950 (Jargowsky 2018; Logan 2016). Federal institutionalization of segregationist mortgage lending made targeted areas more segregated, and then kept them segregated over time. Spatial inequality in the United States, therefore, "is not a surprise result from the invisible hand of the market; it is the intended outcome" (Logan 2016:23).

I also explored two counterfactual scenarios drawn from the article's main findings: one in which HOLC was never implemented and a more radical, anti-racist history in which an intentionally *integrationist* housing policy took hold in the middle of the twentieth century. Both counterfactuals imagine a different United States, with millions fewer African Americans highly segregated from white households—especially during postwar suburbanization. This exercise is a simplified version of history, but it offers an additional tool with which to appreciate the social significance of my results. Absent segregationist housing policies, segregation may not have been granted the same "momentum" (Krysan and Crowder 2017) through unequal access to wealth accumulation (Flippen 2004; Oliver and Shapiro 2006), exposure to neighborhood disadvantage (Sharkey 2008), economic mobility (Chetty et al. 2014), institutional environments (Faber 2019; Rugh and Massey 2010; Small and McDermott 2006), educational opportunity (Reardon et al. 2019), and a host of other spatially-organized social phenomena that shape life outcomes (Sharkey and Faber 2014).

Clearly, massive government interventions work. If the goal is to *reduce* segregation over time, policies with that aim can be designed and implemented. The culpability of the federal government in creating and reifying the color line is directly connected to ongoing, public, and scholarly conversations regarding what is necessary to achieve racial equality (Coates 2014; Massey 2007)—particularly given evidence of continuing discrimination in the mortgage market (Massey and Lundy 2001; Massey et al. 2016; Munnell et al. 1996). Undoing almost a century's worth of damage will likely require as substantial an investment in housing as was made by the suite of New Deal policies, although with specifically anti-racist intent.

Models for this kind of federal investment have existed for decades. Some, in fact, were developed during segregation's peak. The 1968 Report of the National Advisory Commission on Civil Disorders (the Kerner Report) argued that because "[w]hite institutions created [the ghetto], white institutions maintain it, and white society condones it" (U.S. Kerner Commission 1968:1), the federal government must make substantial investments in racial equality. The report recommended spending billions of dollars toward diversifying police departments, creating jobs programs, improving schools, expanding welfare, combating housing discrimination, and building affordable housing (Kendi 2016; Taylor 2019). A year later, then Secretary of Housing and Urban Development George Romney pushed to deny federal funds to states or cities that fostered segregation, build public housing and offer mortgages to black families in white suburbs, and allow the federal government to override local zoning laws (Baradaran 2017; Bonastia 2006; Taylor 2019). Unfortunately, the chief executives at the time—Lyndon Johnson and Richard Nixon—were uninterested in such restorative interventions. Such policies could have had dramatic effects on reducing racial inequality, particularly policies designed to facilitate integration (e.g., overriding exclusionary zoning laws and creating homeownership opportunities for African Americans in white suburbs).

In 2015, the Obama administration issued Affirmatively Furthering Fair Housing rules intended to integrate communities. Unfortunately, that effort was suspended by the Trump administration (O'Regan and Zimmerman 2020). HOLC itself even provides a framework for how to reduce segregation and invest in communities of color. At the most basic level, Residential Security Maps created a racialized geography of financial incentives. We know which places and people suffered from this practice and which thrived.

Using inverted versions of HOLC's original maps to guide contemporary investment could be a step toward racial equality.

The lasting effects of HOLC, FHA, and the GI Bill not only encouraged and institutionalized racist ideas about black people and black places (Kendi 2016; Lipsitz 2011; Sugrue 1996), but invested heavily in them, by restricting black families' access to capital, and increasing white families' access. The segregationist legacy of New Deal housing policies endorsed the idea that racism was a tool with which white Americans could improve their neighborhoods, at the expense of black neighborhoods (Roediger 2006; Taylor 2019). Generations later, this inheritance, or non-inheritance, remains one of the most powerful structural determinants of racial stratification (Desmond 2017; Faber and Ellen 2016; Massey 2007; Oliver and Shapiro 2006).

APPENDIX

Table A1. Graded Cities in the Analytic Sample by Data Source

Both Hillier and Mapping Inequality		Hillier Only		Mapping Inequality Only	
City	State	City	State	City	State
Mobile	AL	Bridgeport	CT	Fairfield	AL
Montgomery	AL	Hartford	CT	Norwalk	CT
Los Angeles	CA	New London	CT	Macon	GA
Sacramento	CA	Waterbury	CT	Belleville	IL
San Francisco	CA	Cedar Rapids	IA	Evanston	IL
Stockton	CA	Council Bluffs	IA	La Grange Park	IL
New Britain	CT	Davenport	IA	Lincoln	IL
New Haven	CT	Des Moines	IA	Kansas City	KS
Stamford	CT	Sioux City	IA	Wichita	KS
Jacksonville	FL	Covington	KY	Chelsea	MA
Tampa	FL	Fall River	MA	Everett	MA
Atlanta	GA	Lawrence	MA	Malden	MA
Augusta-Richmond County	GA	Lowell	MA	Medford	MA
Chicago	IL	New Bedford	MA	Newton	MA
Rockford	IL	Pittsfield	MA	Somerville	MA
East Chicago	IN	Worcester	MA	Woburn	MA
Evansville	IN	Portland	ME	Ferndale	MI
Fort Wayne	IN	Jackson	MI	Independence	MO
Gary	IN	Lansing	MI	Springfield	MO
Hammond	IN	Jackson	MS	University City	MO
Indianapolis city (balance)	IN	Lincoln	NE	Webster Groves	MO
Muncie	IN	Omaha	NE	Clifton	NJ
South Bend	IN	Perth Amboy	NJ	East Orange	NJ
Terre Haute	IN	Jamestown	NY	Englewood	NJ
Lexington-Fayette	KY	Cincinnati	OH	Garfield	NJ
Louisville/Jefferson County	KY	Oklahoma City	OK	Hackensack	NJ
New Orleans	LA	Allentown	PA	Harrison	NJ
Boston	MA	Bethlehem	PA	Paterson	NJ
Brockton	MA	Chester	PA	Pleasantville	NJ
Cambridge	MA	Harrisburg	PA	Summit	NJ
Haverhill	MA	Lancaster	PA	West New York	NJ
Holyoke	MA	Reading	PA	Lackawanna	NY
Lynn	MA	Scranton	PA	New York	NY

(continued)

Table A1. *(continued)*

Both Hillier and Mapping Inequality		Hillier Only		Mapping Inequality Only	
City	State	City	State	City	State
Springfield	MA	Wilkes-Barre	PA	Barberton	OH
Baltimore	MD	Williamsport	PA	Campbell	OH
Battle Creek	MI	York	PA	East Cleveland	OH
Bay City	MI	Providence	RI	Lakewood	OH
Detroit	MI	Columbia	SC	Middletown	OH
Flint	MI	Memphis	TN	Struthers	OH
Grand Rapids	MI	Austin	TX	Bellevue	PA
Kalamazoo	MI	Beaumont	TX	Braddock	PA
Muskegon	MI	Fort Worth	TX	Carnegie	PA
Saginaw	MI	Galveston	TX	Duquesne	PA
Duluth	MN	San Antonio	TX	Franklin Park	PA
Minneapolis	MN	Waco	TX	Homestead	PA
St. Paul	MN	Ogden	UT	North Braddock	PA
Kansas City	MO	Salt Lake City	UT	Wilkinsburg	PA
St. Joseph	MO	Huntington	WV	Newport News	VA
St. Louis	MO				
Asheville	NC				
Charlotte	NC				
Durham	NC				
Winston-Salem	NC				
Atlantic City	NJ				
Bayonne	NJ				
Camden	NJ				
Hoboken	NJ				
Jersey City	NJ				
Kearny	NJ				
Newark	NJ				
Passaic	NJ				
Trenton	NJ				
Albany	NY				
Binghamton	NY				
Buffalo	NY				
Elmira	NY				
New Rochelle	NY				
Niagara Falls	NY				
Poughkeepsie	NY				
Rochester	NY				
Schenectady	NY				
Syracuse	NY				
Troy	NY				
Utica	NY				
Yonkers	NY				
Akron	OH				
Canton	OH				
Cleveland	OH				
Columbus	OH				
Dayton	OH				
Hamilton	OH				

(continued)

Table A1. *(continued)*

Both Hillier and Mapping Inequality		Hillier Only		Mapping Inequality Only	
City	State	City	State	City	State
Lima	OH				
Lorain	OH				
Portsmouth	OH				
Springfield	OH				
Toledo	OH				
Warren	OH				
Youngstown	OH				
Altoona	PA				
Erie	PA				
Johnstown	PA				
McKeesport	PA				
New Castle	PA				
Philadelphia	PA				
Pittsburgh	PA				
Chattanooga	TN				
Knoxville	TN				
Nashville-Davidson	TN				
Lynchburg	VA				
Norfolk	VA				
Spokane	WA				
Tacoma	WA				
Kenosha	WI				
Madison	WI				
Milwaukee	WI				
Racine	WI				
Charleston	WV				
Wheeling	WV				

Note: "Hillier" refers to census places listed by Hillier (2005) as appraised by HOLC; "Mapping Inequality" refers to census places that geographically overlap with HOLC Residential Security Maps provided by Nelson and colleagues (2019).

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Notes

1. The Census defines places as "a concentration of population; a place may or may not have legally prescribed limits, powers, or functions. This concentration of population must have a name, be locally recognized, and not be part of any other place" (U.S. Bureau of the Census 1994:9-1).
2. Residential Security Maps were generated for a small number of counties and metropolitan areas,

which are discussed in the Measuring Redlining subsection.

3. The Hillier (2005) list mistakenly includes Peoria, Indiana, on the list of surveyed cities. Through direct correspondence with the National Archives and Records Administration, I confirmed that HOLC appraisers created a Residential Security Map for Peoria, Illinois (i.e., not Indiana).
4. Hillier (2005) notes it is possible that some maps were simply lost over time.
5. Wards are only available for the 1 percent sample in 1910.
6. Dissimilarity is calculated as $D = \frac{1}{2}\sum_{i=1}^{N}\left|\frac{b_i}{B} - \frac{w_i}{W}\right|$, isolation is calculated as $I = \sum_{i=1}^{N}\left[\frac{b_i}{B} * \frac{b_i}{t_i}\right]$, and information theory is calculated as $H = 1 - \sum_{i=1}^{N}\left[\frac{b_i}{B} * \frac{b_i}{t_i}\right]$. N is the number of neighborhoods (i.e., tracts, wards, or enumeration districts) within a census place. B and W are the total number of black and white residents within a census place, respectively, and b_i, w_i, and t_i, are black, white, and total populations within a neighborhood.
7. IPUMS staff indicated there is no plan to add this information to the public, complete count dataset.
8. NHGIS provides tract-level datasets for years prior to 1950, although they are very limited. The 1940 dataset only has tract-level data for 83 cities. In 1930, there is effectively no tract-level data in the South (only Nashville is included) and 1920 tract-level data only include Chicago, New York, Cleveland, and Milwaukee. Because of these limitations, I proceed with the individual-level data from IPUMS.
9. Enumeration districts are not available for 1920.
10. Figure S1 in the online supplement shows that the main findings of this article are insensitive to the size of the black population requirement as well as the tract/ward number requirement. Specifically, results suggest a significant effect of HOLC on segregation among cities with black populations as high as 2,000. Results are considerably stronger when the tract/ward requirement is increased.
11. Table S6 in the online supplement shows that the relationship between HOLC appraisal and segregation trends is much stronger within a larger sample that does not restrict by these criteria. Table S7 shows that the main results hold even after excluding data from 1950 and 1960. These two years are likely the noisiest because they are the smallest samples, but they also offer imprecise estimates because I aggregate tract-level data to places in these years and rely on non-white homeownership rather than African American homeownership in these years.
12. Table S8 in the online supplement further supports the validity of this assumption by estimating each segregation index as a function of year indicator variables and year-by-HOLC interactions omitting the last pre-HOLC year (i.e., 1930). The coefficient on the interaction between 1920 and HOLC graded status is only significant in the full sample model of isolation. This interaction is non-significant in all three restricted sample models.
13. When distance is measured linearly, there is a negative and significant coefficient on kilometers from HOLC map. When distance is measured quadratically, there is again a negative and significant coefficient on kilometers from HOLC map as well as a positive and significant coefficient on squared distance, suggesting a diminished relationship at long distances, which is supportive of the decile-based results.
14. Covariate coefficients are presented in Table S9 in the online supplement.
15. The *graded by HOLC* variable drops out of Models 4 and 5 because it does not vary over time within cities.
16. The changing number of places analyzed by year is a potential source of bias, as sample attrition and addition is likely non-random. My primary analytic sample is unbalanced, but estimates within a balanced panel of places for which I have complete covariate data in every year also suggest a significant difference between graded and ungraded areas, although the dissimilarity results are weaker (see Table S10 in the online supplement). The size of the DID estimators are larger in the balanced sample, suggesting results within my analytic sample may be conservatively biased.
17. Standard deviation was calculated after excluding the smallest and largest 1 percent of cities for conservative estimates.

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