This chapter will contribute to the nascent field of energy justice and energy insecurity in the United States by examining the long-term impacts of systematic racism in the form of red-lining on energy efficiency of the housing stock currently occupied by African Americans and other minorities. Noting that energy insecurity, defined as the condition wherein a household spends greater than 10% of income on energy, is a function of household income and housing quality, I propose examining energy justice through the lens of housing stock energy efficiency. This chapter’s aim is to disentangle the economic and social drivers that lead to high rates of energy insecurity, moving beyond the notion that “poor people don’t value efficient homes.”

## Energy Insecurity

The energy insecurity literature contains evidence that low-income households frequently face excessive energy bills, despite their income limitations, that initially seem counter-intuitive (Hernández, 2015; Hernández & Bird, 2010). This inequality is not just that low-income households have a harder time paying their energy bills, but that poor people are paying more to attain the same level of energy services. This brings to mind the phrase “it’s expensive to be poor in America.” A lack of investment, or ability to invest, is often cited as the basis for this notion. For instance, an inexpensive used car is more likely to be mechanically faulty or have serious underlying issues that are repetitive and costly. A low-income household may be unable to invest in a more reliable car, but then suffers increased breakdowns and frequent repair bills, reducing wage income two-fold. In this case, the issue may be credit constraints or lack of ability to save.

Some of this insecurity is attributable to the housing stock, which is less energy efficient in low income and minority neighborhoods. Previous work in this area has found negative correlations between energy efficiency and racial characteristics at the census block-group level (Reames, 2016), and many have noted the disproportionate “energy burden” faced by low-income households. With tight budget constraints, low-income households are more likely to consume lower-priced housing. Naturally, lower priced housing stock will be deficient in some areas. Maintenance may be less frequent or non-existent, structural problems may plague the home, and the home may have un-remediated lead paint or asbestos. Similarly, it is more likely that the home is poorly insulated, has single-pane windows, and has dated, inefficient systems for heating and cooling. These characteristics are common amongst low-income housing, and are intertwined with poor child health and development outcomes, and with food insecurity (Cook et al., 2008).

That energy insecurity is common amongst low-income households and those who face food insecurity is not surprising. However, even when controlling for poverty rates, Reames (2016) finds that minority-dominated census block-groups and those block-groups with high measures of racial segregation also tend to have worse energy efficiency. That is, even conditional on poverty, minority areas may have lower-efficiency housing stock relative to non-minority areas. Not only is energy insecurity an issue, but so too is *energy inequity* – the disproportional incidence of energy insecurity in heavily-minority areas relative to non-minority areas of similar income.

This brings the question central to this chapter: *what drives the wedge between the energy efficiency of the housing stock available to (and chosen by) minorities and the energy efficiency of the housing stock available to (and chosen by) non-minorities of similar economic status?*

## HYPOTHESIS

This proposed chapter posits a hypothesis for how this energy inequity came into being and why it persists over time. Specifically, I propose that institutional discrimination in the 1930s-1970s forced African-Americans into segregated communities and, over this period, the housing stock in these communities, though similar at one point in time, *developed* differently. This historical racism has persistent long-term effects on housing choices and housing quality for African-Americans that explains, at least in part, the energy inequity we observe today.

This chapter will connect three hypotheses:

**Hypothesis :** Red-lining served as a “critical juncture” which split access to housing stock by race.

**Hypothesis :** This split allowed for divergence in the structural drivers of home energy efficiency through self-reinforcing mechanisms and institutionally-imposed racial segregation, e.g., differential access to credit, decreased own-home ownership, and increased absentee landlords. Essentially, not only did red-lining segregate residents, it changed how housing stock developed over time. Together, these two hypotheses explain the separated equilibrium observed today – a “historesis” effect.

**Hypothesis :** The persistence of these inequalities after the Community Reinvestment Act of the late 1970 made red-lining illegal is a result of high moving costs and reliance on established social networks. For this, I draw on the social network and residential sorting literature to understand the unobserved incentives individuals have to sort into areas with low-efficiency housing. Primarily, preference to be near family and social support networks create unobserved costs of migration for individuals who would otherwise prefer higher quality housing. Facing higher costs to sever ties and support, individuals rationally choose to remain in areas whose housing stock energy efficiency is stunted by historic segregation.

The current literature bears out this effect. Preferences for own-race homogeneity (Bayer, Ferreira, & McMillan, 2007; Bayer, McMillan, & Rueben, 2004) are well-known, though not wholly straightforward (Bayer, McMillan, Murphy, & Timmins, 2016). Even with minor tastes for own-race homogeneity, neighborhoods may quickly reach a “tipping point” where sorting occurs, rendering areas segregated (Schelling, 1971; Zhang, 2011). Even post-redlining, (Fischer, 2003) finds that poor blacks are *uniquely* segregated relative to poor whites. Furthermore, evidence suggests that own-race homogeneity may improve outcomes, especially for migrants (Cutler & Glaeser, 1997; Cutler, Glaeser, & Vigdor, 2008).

To be clear, these hypotheses do not, on their own, rule out other confounding explanations for the observed energy inequity. Confirming that these effects exist is a necessary but not sufficient step towards understanding the phenomenon. In this prospectus chapter, I discuss the empirics necessary to test these hypothesis, but acknowledge that even a successful effort does not establish causality.

The results of these hypotheses should provide guidance and direction for further work on racial segregation and energy efficiency. […]

## Data for Testing Hypotheses

The empirical strategy for testing the presence of a historesis effect relies on identifying a connection between historic redlining and current energy efficiency while controlling for all possible confounders. To this end, it is necessary to define a measure of energy efficiency, and to identify redlined areas.

Energy efficiency is commonly measured in energy use intensity (EUI), which is energy consumption for a household normalized by household building area. Measures of EUI may be calculated from some of the decennial censuses and in the American Housing Survey, the 3-year rolling sample designed to replace the decennial housing long-form questions. However, because the U.S. census does not report tables of these variables by block-group, instead reporting only over states and census regions, census data necessary to form time series of EUI at the block-group level is only available through restricted access census microdata. I have initiated the access process as of March 2017. When approved, I will have access to these data through Duke’s Census Research Data Center, located within the Social Sciences Research Institute (SSRI).

Other data from the census will be obtained simultaneously. Data on distributions of income-by-race, tenure (home ownership), and migration status (including “city of residence 5 years prior”) will likely be of use.

I have obtained maps for 143 metropolitan areas prepared in the 1930’s by the Homeowners Loan Corporation (HOLC) that are color coded by “desirability.” On these maps, areas were coded “red” if they were “undesirable” with high shares of “subversive” minorities. These red areas were the only areas suitable for lending to minorities. “Yellow”, “green”, and “blue” areas are also indicated on the HOLC maps, corresponding to progressively fewer minorities. These maps represent the closest available correspondence to areas institutionally segregated through mortgage lending practices. It is well known that there is no single, official “redlining” map, as the practice was an amalgamation of local ordinances, deed restrictions, informal understandings between banks and real estate agents, and social pressure. The HOLC maps are believed by some (though not all) to be the origination of the term “redlining.”

I can overlay these maps with census blocks or block groups. At the block-group level, the intersection is fairly consistent – current block-groups are drawn to have common features or geographies, and thus tend to capture redlined areas well. The spatial data, once merged with data on EUI from the censuses, forms a panel of block-groups and energy efficiency observed over time. Furthermore, the HOLC maps contain additional information in the form of copies of the original survey notes for many municipalities. When available, the surveys include breakdowns of racial composition, the average home value and rent value, the overall condition and vintage of housing stock, and specific details on the types of minorities residing in each area.

## Testing Hypotheses

The first step in my analysis is to conduct a reduced form regression of energy efficiency on historic redlining, controlling for time effects and household income at the census-block level. The appropriate regression model would be of the form:

Where is the block-group index, t is the census year, and is a time- and county-specific fixed effect that captures region-specific changes in EUI over time, including weather-related changes, changes in utility rates, and changes in home heating or cooling technology common over a metropolitan area. Other relevant controls specific to the block-group level are contained in . My expectation is that is positive and significant, even when controlling for income, race, and unobserved county-time specific shocks. Identification is from within-county variance in EUI correlated with HOLC map rating.

### Testing Hypothesis

Assuming a historesis effect is identified, the task is to find potential drivers of the path EUI follows in redlined and non-redlined areas. The next step I propose taking is to test Hypothesis , that red-lining served as a “critical juncture” which split access to housing stock by race by the 1940 census. At first, this seems obvious as the intent and the well-known outcome of redlining was racial segregation. However, two situations may confound the effect. First, the effectiveness of institutional redlining may not have been complete. Minorities may have been able to acquire mortgages in the “yellow” ranked areas on the HOLC maps. Second, the outbreak of World War II integrated many industrial workplaces and shifted large populations of minorities, especially in the growing West (Kusmer, 1995). While this integration was largely short-lived, the war altered ownership patterns and segregation.

Racial segregation may be measured in a variety of ways. Here, I use the familiar GINI coefficient, as well as the racial fragmentation measure used in (Costa & Kahn, 2003). Denoting each racial category by , and the share of block-group population in that category as , the fragmentation measure is defined as:

Testing is simply a matter of calculating the significance of the difference in means for redlined block-groups to non-red-lined block groups.

### Testing Hypothesis

This hypothesis states that, once housing stock was “split,” the time-path of housing stock energy efficiency developed differently in redlined areas than in non-redlined areas. One potential cause is that segregation from redlining changed patterns of home ownership, which in turn alters incentives for investing in energy efficiency (e.g. the “principal-agent” problem, (Murtishaw & Sathaye, 2006)). Home ownership rates are also closely intertwined with intergenerational wealth, which in turn drives economic outcomes over time (Shapiro, Meschede, & Osoro, 2013). Another potential cause is that credit constraints (Golove & Eto, 1996), also an outcome of institutional discrimination, made efficiency upgrades in redlined areas more costly, even when redlining made home ownership *more* likely.

Testing the presence of these drivers requires data on (a) home ownership rates in block-groups (available in most decennial censuses), (b) race and residence of landlords, (c) intergenerational wealth (generally not available in any census at the block-group level), and (d) credit availability (generally not available in any census at the block-group level). Clearly, any empirical strategy would leverage observable home ownership rates at the block-group level, and credit availability and distributions of intergenerational wealth over race at greater aggregation, relating the phenomenon of lower (or higher) home ownership in redlined areas to larger trends in credit and wealth.

*A priori,* I am agnostic as to the sign on the effect of redlining on home ownership rates. On one hand, institutional discrimination may suggest an overall increase in costs and reduction in availability of mortgages for African American applicants, regardless of location. In this case, the data would show lower ownership rates in redlined areas. However, clustering of African Americans (and other minorities) into enclaves may increase the likelihood of obtaining a mortgage relative to minorities outside of the enclave, possibly as a result of social capital (Cutler et al., 2008). If redlined areas lead to higher home ownership conditional on income, and regional or national trends in credit availability and intergenerational wealth point towards lower investment (or higher costs to invest) in housing stock, I would expect to observe a languishing housing stock with EUI increasing relative to other areas with similar housing characteristics and income. This would be particularly true if those minorities that were originally segregated into redlined areas later become landlords, renting out the home but still facing constraints on credit for upgrades. However, if redlined areas lead to lower home ownership, the unfolding of home energy efficiency over time may be best explained by the principal-agent problem. At this juncture, I have not yet developed models for testing this hypothesis, but will follow the concepts presented here.

It is important to note the difficulty of identifying the effects of racial segregation separate from the effects of income. Any low-income area will likely have poor EUI development over time, simply due to the constraints of residents and rental values for absentee landlords. Landlords with housing that draws primarily low-income renters will have little incentive to upgrade the home’s energy efficiency. In rent-controlled areas, landlords may even use energy inefficiency as a means of transferring costs from owner to occupant[[1]](#footnote-1). A suitable counterfactual may exist in the Rust Belt of the Northeast, particularly in Ohio, Pennsylvania, and West Virginia. In these regions, historic labor migration is largely comprised of poor whites leaving Appalachia for work in the new factories and foundries nearby to the north. In these areas, such as Cleveland, Ohio; Charleston, WV; and Pittsburgh, PA, we observe block groups of poor whites as well as poor black with similar income distributions, but different treatment in regards to redlining. This forms the core of my identification strategy.

## Testing Hypothesis

*The persistence of these inequalities after the Community Reinvestment Act of the late 1970 made red-lining illegal is a result of high moving costs and reliance on established social networks.*

The literature is rich with evidence of preferences for racial homogeneity (Bayer et al., 2004; Schelling, 1971), and evidence of social and human capital returns to segregation (Borjas, 1998; Costa & Kahn, 2003; Cutler & Glaeser, 1997). However, any constraint on migration is, by definition, weakly welfare-reducing. The data bears a fuzzy “break” in institutional enforcement of segregation with the Community Reinvestment Act (CRA), which forbade racial restrictions on lending either directly or indirectly. For the hysteresis effect to still be observable today requires that, even in the absence of institutional segregation, some other force persists that makes migration to more efficient housing stock costly or difficult. The bulk of the human capital returns to segregation rely on the characteristics of those migrating into the area to identify this effect. I propose focusing on the characteristics of those who remain after the CRA implementation to elucidate the drivers of continued preferences for energy-inefficient housing.

Consider a model with two communities, , within one region. The community is defined at the census block-group level, while the region may be defined as an MSA. One community was historically redlined (, while the other ( is merely in the same spatial area as the other. Define three individuals , where *a* currently resides in *r*, b currently resides in *g*, and *m* is an immigrant. Let *m*’s immigration decision be exogenous – that is, consider *m* to be randomly assigned to the region. This is not far-fetched – while choice of region may be correlated with a random draw of regional wage offers or some endogenous preference for the region, it is unlikely that this shock or preference would be specifically correlated to the neighborhood level. This follows a portion of the literature on residential sorting where individuals choose a metropolitan area in a first stage, then make a specific housing choice in a second stage (Bayer, Keohane, & Timmins, 2009). I diverge from this literature in that my interest is in the cost of moving *in* or *out* of a given community. Specifically, I am interested in the costs of moving out of *r* relative to *g*. This speaks to the existence of underlying motivations for remaining in a formerly redlined area, despite energy inefficient housing stock. If an unobserved social-network effect exists, it will manifest in higher out-migration costs.

Over some time period, all three individuals consider moving to any of the two communities in the region. Let be the (time-constant) observable characteristics of each *c* and let be the parameters of shared tastes for observable characteristics. includes the expected energy costs (or elements of the distribution of energy costs) for *c*. Each community has a cost of entering, , as well as a cost of leaving . Individual , the migrant, faces a sunk cost of leaving their original region that is ignored. The utility of moving to community *c* depends on original location and preferences for attributes common in :

The parameter of interest is , the difference in out-migration costs between formerly redlined areas and non-redlined areas holding observable characteristics and household characteristics as fixed, and controlling for expected energy cost differentials. A significant difference indicates that some unobserved value exists for remaining in an area with substandard energy efficiency. A cursory examination of the set of utilities shows that may be identified from the choices made by *b* relative to *m*, and is identified from *a*’s choices relative to *m*. ’s identification follows similarly.

is not necessarily identified separate from deviations in taste for *r*. That is, if *a* has a deviation in taste for an observable characteristic (described by the common for some characteristic of *g*, it will be subsumed into . This particular issue is not yet addressed in my model. The model here is simply an initial attempt at a framework for understanding and identifying the hypothesized phenomenon. A great deal of work is necessary to relax assumptions and control for endogeneity.

## Policy Relevance

Findings from this research would provide useful information for policy. First, it would speak to the past *and current* effects of historic segregation, and help to understand current drivers of disproportionate energy burdens. This understanding would, in turn, help inform policymakers concerned with energy poverty. If low-income people cannot pay their energy bills simply because they make too little money, then current strategies to provide subsidies for energy to the lowest earners may alleviate the problem. If, however, energy inequality is a function of both low income and poor housing stock, then subsidizing energy costs the state money that may not ultimately increase the energy resources (e.g., thermal comfort) of low-income people.

Beyond the research avenues discussed here, the project leaves many possible paths open for exploration. For example, the relationship between racial minorities and government-driven energy efficiency programs may play a part in explaining some of the path of housing stock energy efficiency. In areas where trust in government institutions is low, residents may be less likely to participate in efficiency programs such as energy audits, requiring programs that acknowledge local and racial context (Bednar, Reames, & Keoleian, 2017).

A second potential path for this research would be to use redlining as an instrument for housing segregation. This path would follow (Ananat, 2011), which identifies the causal effect of segregation on African American poverty by instrumenting for segregation with 19th century railroad track layouts. The author shows that railroad track layout and geographic features facilitated segregation in some cities, but not in others, providing an exogenous source of variation in segregation, which is plagued with endogeneity issues. Redlined areas could feasibly serve as a similar instrument.

[[[END]]]

Bayer and McMillan etc. – black people move to be with black people. Read the rest of the papers I pulled up.

Think about outmigration of whites “leaving behind” areas adjacent to black redlined areas. Do they tell us anything? They become controls when we look at redlining as they were, at the time, separate. Identification of redlining might depend on them.

Tiebout sorting tells us people move and sort. Fishel tells us zoning is like an economic pricing system (not sure if that helps). Costa and Kahn (2003) – homogeneity breeds social capital.

Glaeser, Kahn, and Rappaport (2006) suggest poor live in cities because public transport (not sure if that helps). Model of elasticity of demand for land (previous claim of cause) doesn’t show this is the case. Commuting costs make more sense in model.

Bajari and Kahn (JBES2005) find blacks willing to pay for white neighborhoods, and whites willing ot pay for integration ?

1. This topic may make an interesting secondary paper examining rent-control and energy inefficiency. I thank Seth Sanders for noting this possibility. [↑](#footnote-ref-1)