The Effect of Minority History on Racial Disparities in the Mortgage Market: A Case Study of Durham and New Haven

Jisoo Yoon*

Professor Christopher Timmins, Faculty Advisor

April 17, 2015

Duke University
Durham, North Carolina
2015

I am a senior at Duke University majoring in Economics with a minor in Mathematics. In the fall of 2015, I will be joining J.P. Morgan's securitized products trading group in New York.

Acknowledgements

Abstract

In the aftermath of the housing market crash, the concentration of subprime mortgage loans in minority neighborhoods is a current and long-standing issue. This study investigates the presence of racial disparities in mortgage markets by examining two cities with contrasting histories of African American and Hispanic establishment: Durham, North Carolina and New Haven, Connecticut. This study examines data by the Home Mortgage Disclosure Act (HMDA), and distills the effect of minority legacy on the perception of racial risk by using econometric instruments to separate the behavior of national lenders and local lenders. The econometric methods allow national lenders to reflect objective risk measures and neighborhood race dynamics, while local lenders reflect subjective attitudes towards certain races. With its longer history of African American presence, Durham shows a positive attitude towards Black borrowers at the local level, while New Haven shows a more favorable attitude towards its Hispanic residents. Nonetheless, racial legacy also materializes as a negative factor in the form of increased residential segregation and spillover effects. Furthermore, a temporal variation analysis of pre- and post-mortgage market reform data affirms the disappearance of racial bias and continued presence of spillover risk in Durham.

I.   Introduction

The dramatic run-up and subsequent collapse of the US housing market in 2007 was an unprecedented phenomenon in real estate history. No brief period in the past witnessed such a drastic home price escalation of nearly 50% followed by a rapid 30% drop (Brueckner 2012). One of the main factors experts have pointed to for this collapse of the housing market is the increase in subprime mortgage lending. The disproportionate impact of the subprime crisis on minority groups has especially been a subject of much debate (Demyanyk 2009). While mortgage market reforms such as the 2010 Dodd-Frank Act have been implemented to eliminate predatory lending that targets certain demographics, the racialization of risk in the mortgage market remains a topic of much economic inquiry. Past studies on racial bias in the mortgage market have largely focused on analyzing single isolated regions using loan data prior to the 2010 reforms. In order to determine the extent of racial bias in the mortgage market, this paper takes a unique approach. This paper compares the mortgage lending patterns of two different regions with contrasting legacies of African American integration: Durham, North Carolina and New Haven, Connecticut. Using regression methods that reflect the difference in local racial perception resulting from contrasting urban histories, this paper examines the presence of racial bias in the two cities. This study also employs an updated dataset ranging from the years 2007 to 2013 in order to identify the changes that occurred since the mortgage market reforms of 2010.

Leading up to the 1990s, racial minorities in the U.S. were historically limited from access to credit and mortgage financing due to bank-redlining and regulatory discrimination (Dymski 2009). Race was considered a significant risk factor in diminishing property value, and such racialization of credit risk and consequent difficulty of taking out mortgages often resulted in the crowding of minorities into segregated neighborhoods (Zonta 2012). Following the recession

of the 1970s, however, deregulation in the financial markets and government policies promoting homeownership opened up the availability of mortgage-finance to minorities (Wonderly 2011). Coupled with the development of mortgage-backed securities (MBS) and integration of consumer finance with the broader capital market, this gave rise to a rapid expansion of mortgage lending to minority borrowers (Ashton 2012).

The increasing demand for mortgage loans incentivized mortgage brokers to push unsafe mortgages onto unqualified consumers (Bhutta 2010). Consequently, the 1990s and 2000s saw a dramatic increase in high-risk lending practices and subprime loans. Between 1994 and 2003, prime loans increased by 18% annually, while subprime loans increased by 25% per year (Smith and Hevener 2011). The subprime mortgage market experienced explosive growth between 2001 and 2006, largely facilitated by rising demand for private-label MBS that, unlike the MBS guaranteed by government-sponsored enterprises like Freddie Mac or Fannie Mae, lacked credit risk protection. Rising investor demand for higher-yielding private label MBS drastically increased the share of risky subprime loans in the market from 8% in 2001 to 20% in 2006 (Damyanyk and Van Hemert 2011). During such dramatic growth of the subprime mortgage market, the quality of loans also deteriorated due to loose underwriting standards and low risk premiums. Consistent appreciation in housing prices masked the deterioration of mortgage quality and the increasing riskiness of subprime loans (Demyanyk 2009). When housing prices stopped escalating, the immense riskiness of subprime mortgages became apparent. Waves of mortgage defaults and foreclosures ensued, resulting in the U.S. housing bust and the subprime mortgage crisis.

In the aftermath of the housing market crash, the concentration of subprime loans in minority and low-income neighborhoods brought up concerns that such demographics were targeted for high-cost loans and barred from

opportunities to access prime mortgages. Previous studies have raised the issue of racial disparities in the mortgage market. In 2000, the Department of Housing and Urban Development (HUD) and the Treasury reported that, on average nationwide, subprime loans were five times more frequent in predominantly Black neighborhoods than in predominantly White neighborhoods in 1999. Moreover, one in every two refinance loans were subprime in Black neighborhoods, in contrast to only one in every ten for White neighborhoods. Most literature note that discrimination in the mortgage market has been based on race, and that the African American population may have been disproportionately impacted by predatory subprime lending (Bradley 2000). Moreover, after controlling for borrower and loan risk factors, African Americans and Hispanics are more likely to receive a subprime loan while Asians are less likely to do so (Avery et al. 2006).

Many studies thus far have shown evidence for racial prejudice in various mortgage markets, primarily in major cities across the United States. Calem et al. (2004), DeLoughy (2010), Smith and Hevener (2011) and Dymski (2001) all empirically examine mortgage data from various metropolitan areas, discovering that a significant concentration of subprime lending exists among minority borrowers, especially Blacks and Hispanics. While studies such as that those by Haughwout et al. (2009) raise the possibility that the significance of the race variable may not be consistently strong, most literature agree that racialized risk does play a role in determining one's chance of getting a subprime mortgage.

This paper expands on the analyses conducted by previous studies by applying different econometric techniques to make geographic and time-series comparisons. Like past studies, this paper uses the mortgage loan data made public under the Home Mortgage Disclosure Act (HMDA). Unlike past studies that have relied solely on Ordinary Least Squares (OLS), logit or probit regressions, this study also incorporates the tobit model in order to correct for

censoring in the HMDA data. Furthermore, this study categorizes mortgage lenders as either national or non-national (local) in order to distill the effect of local race perception on lending dynamics.

While all past research has examined data from similar regions, this paper compares lending patterns between two very different areas. In particular, this study examines mortgage data from Durham, N.C. and New Haven, C.T. Focusing on the difference in African American heritage between the two college towns, this paper studies how the difference in racial legacy affects racial prejudice in the local mortgage market. Distinct from past studies, this paper also examines the most current mortgage data from 2007 to 2013 in order to determine the effect of mortgage market reforms on lending patterns.

In addition to a geographic comparison between Durham and New Haven, temporal variation is used in this study to assess the effect of the 2010 mortgage market reforms. The Mortgage Reform and Anti-Predatory Lending Act ("Mortgage Reform Act"), incorporated as Title XIV of the Dodd-Frank Act in 2010, implements various mortgage origination regulations aimed at eliminating practices that contributed to the housing market collapse. With its focus on eliminating biased risk measures and enforcing stricter lending standards, the Mortgage Reform Act has brought changes to mortgage lending practices that may become apparent in the empirical results of this study.

In summary, this paper makes a unique contribution to the field by examining the effect of racial history on how lenders perceive racial risk in mortgage markets. In order to test this hypothesis, this study introduces national lenders as a control for unbiased lending and uses regression methods that correct for censored data. This paper therefore examines whether a geographical legacy of African American heritage influences the degree of racial disparity in the mortgage market. By comparing the significance of the race and local lender variables in determining mortgage rates in Durham and New Haven, this paper

shows the influence of history on the local perception of racial risk. Moreover, by examining pre-crisis and post-crisis datasets, this paper determines whether the predominance of subprime lending among African Americans has changed since the mortgage crisis.

The main hypothesis of this paper is that Durham, with its longer history of African American heritage, would show more favorable or less-biased attitudes towards minority borrowers, especially Blacks and possibly Hispanics, than New Haven. The first hypothesis of this paper is that the Black variable will be less positively correlated with subprime rates for Durham than New Haven due to Durham's history of better racial integration. The second hypothesis of this paper is that the 2010 mortgage reforms have diminished the degree of racial disparity in the mortgage markets of both cities. The final hypothesis of this paper is that regional complexities arising from racial dynamics may outweigh conventional credit risk factors in determining lending decisions.

This paper is organized as follows. Section II presents a review of past literature on racial bias in subprime lending and the racial history of Durham and New Haven. Section III presents data on the mortgage loans, income and demographics of the two cities. Section IV discusses the theoretical framework and considerations for determining the existence of racial prejudice in subprime mortgage loans, while Section V shows the variables, empirical estimation and results of the regression model. Section VI briefly concludes.

II.   Literature Review

II.1   Past studies on racial bias in the mortgage market

Some important literature provide this paper with historical context on the role of race in the mortgage market. In a 2012 analysis on the history of racialized risk, Ashton takes note of the dramatic transformation of minority borrowers, especially African Americans, from decades of racial exclusion to exploitation

within the subprime market. Historically, minorities had been excluded from mortgage-finance because they were perceived to have higher credit risk. Fewer loans were made to African American neighborhoods, which in turn diminished resources to upkeep their real estate. This further led their property values to decline, creating a vicious cycle of segregation in the mortgage market. However, changes in economic policy such as financial deregulation in the 1980s and lower interest rates created an environment for increased risk-taking, which began to disproportionately expose minority households to high-cost lending in the subprime mortgage market. In a 2013 paper, Dymski et al. also argues that institutional changes in regulatory policy, financial markets and banking strategy led to the super-inclusion of minorities in subprime mortgage lending. Historically, banks ignored and under-served minority areas because the Federal Housing Administration (FHA) underwriting criteria explicitly discriminated against minority neighborhoods. Pressure from the 1960's Civil Rights movement eventually opened the FHA program to minority areas, but financial deregulation incentivized banks to further retreat from minority borrowers. Predatory lenders became the dominant providers of financial services in low-income and minority neighborhoods, originating increasing numbers of subprime loans to less-privileged households. Between 1993 and 1999, the total amount of subprime loans grew by a staggering 900% (Dymski et al. 2013).

Past empirical examinations of lending activity in urban tracts confirm that African Americans are most prominently subject to high-cost subprime loans. A 1999 study by Canner et al. presents evidence that, in 1998, 15.6% of loans to Black households were subprime whereas the share of subprime loans in the entire mortgage market was only 6%. Canner et al. also show that subprime lending increased the number of loans to minority households. More than one-third of the growth in overall lending to minority neighborhoods from 1993 to 1998 was due to the increase in subprime lending (Canner et al. 1999).

The 2004 study by Calem et al. lays the groundwork for identifying racial prejudice in mortgage lending patterns. In this paper, Calem et al. investigate the spatial concentration of subprime lending across census tracts within Chicago and Philadelphia by controlling for tract-level and borrower-level risk measures. Their primary source is the 1999 HMDA data. HMDA began disclosing exact mortgage rate values in 2004, so Calem et al.'s dataset is limited in that it cannot identify subprime loans based on interest rate information. Furthermore, HMDA data is limited in that it does not provide information on the loan applicant's credit risk. Calem et al. therefore supplement their HMDA data with other sources. They match the Department of Housing and Urban Development (HUD) list of subprime lenders with the lenders in the HMDA data to determine if the loans are subprime or prime. In addition, they use the Census data from 2000 and private data sources like CRAWiz to collect information on the Census tract and individual credit ratings. Calem et al. build tract-level and borrower-level regression models for subprime purchase and refinancing loans from Philadelphia and Chicago. Their models are robust in that they control for tract-level credit risk by using residents' credit scores from private data sources. Their study focuses on the treatment of African American borrowers, and concludes that the presence of African Americans, either as homeowners in the tract-level model or as individual borrowers in the borrower-level model, is found to be strongly related to subprime lending in both cities. Calem et al. also note that a borrower's level of education is a significant factor in gaining access to prime loans, since individuals who are more aware of various mortgage products can avoid turning to subprime options.

DeLoughy's 2010 study replicates Calem et al.'s methodology by focusing on three Connecticut cities with large African American and Hispanic populations: Bridgeport, New Haven and Waterbury. The study analyzes subprime mortgage lending patters in the three cities by examining the 2006 HMDA data, 2000 Census and a private data source. The Census data is used in

combination with the HMDA data to construct demographic and borrower risk measures for each census tract in the Connecticut cities. Similar to Calem et al., DeLoughy uses the 2005 HUD list of subprime lenders to code each loan as subprime or prime. DeLoughy uses two regression models in the data analysis. The first model is an OLS regression that estimates the probability of getting a subprime loan against tract-level factors like the tract's racial composition and median home value. The second model is a logit regression that estimates a binary variable indicating whether the loan is subprime against tract-level and borrower-level risk measures like the borrower's race and income. This methodology enables DeLoughy to control for various risk factors and isolate race as a significant determinant of subprime lending, but does not incorporate individual credit metrics like loan-to-value (LTV) or debt-to-income (DTI) ratios. Consistent with Calem et al.'s study, DeLoughy's analysis concludes that the indicator variable for Black borrower is consistently significant for all cities, and is positively correlated with the probability of getting a subprime loan. The indicator variable for Hispanic is also significantly positive for all cities and has a larger magnitude than the Black variable. The Asian race variable shows mixed and insignificant results. The study also discovers that typical risk variables like borrower's income do not appear to be significant determinants of the odds of getting a subprime loan. This may indicate that, in 2006, risk was not properly factored into subprime lending decisions. However, the analysis leaves room for further debate in that the race variables produce mixed results in tract-level equations, but are generally significant and positively related to subprime lending in the borrower-level models. This suggests that the association between risk and race may differ by market.

A 2011 study by Smith and Hevener introduces additional credit risk variables to better control for factors correlated with race. Using HMDA data on home purchase loans in Pennsylvania, New Jersey and Delaware from 1999 to

2007, this study examines the gap in subprime rates between African Americans and Whites, and estimates the change in the Black-White mortgage rate gap over time. Smith and Hevener combine the U.S. Census, HUD and private data sources with the HMDA data. Noting that the HUD subprime lender list was discontinued in 2005, Smith and Hevener use the mortgage rate spread information provided by HMDA to categorize loans as subprime. The paper employs a logit regression that uses a binary variable indicating a subprime loan as the dependent variable, and a combination of tract- and borrower-level risk measures as explanatory variables. Consistent with past studies, Smith and Hevener find that the coefficient of the Black variable is positive and statistically significant in the regressions for all years, implying that African Americans have a high probability of getting a subprime rather than a prime loan. Although the Black-White gap in subprime rates cannot be fully explained with the race factor alone, the statistical significance of the Black variable suggests that race does play a role in influencing whether a borrower receives a subprime loan instead of prime mortgages.

Dymski's research in 2001 is particularly relevant to this paper, as it takes into consideration the effect of history on the race factor in mortgage lending decisions. Dymski presents two definitions of discrimination − one is an *ahistorical* approach which controls for historical differences and focuses solely on contemporary predatory behavior; the other is a *structural* approach which includes historical differences attributable to racial oppression. Dymski accepts the *structural* approach to investigate the determinants of purchase loan approvals. The paper examines a time-series HMDA data from 1992 to1998 for seven California cities and eleven non-California metropolitan areas. The paper only uses HMDA data, and employs a logit regression in which the dependent variable is a binary variable indicating the purchase loan approval, and the independent variables are tract- and borrower-level risk measures and year

indicator variables. Dymski concludes that African Americans and Hispanics have a persistent disadvantage in obtaining loan approval in all 18 cities. Asians have a statistical disadvantage in some cities, whereas Whites consistently have a positive advantage. In non-California cities, the disadvantage of Blacks and Asians noticeably decreased but the significant disadvantage of Hispanics remained unchanged. Nonetheless, the probability of loan approval for African Americans consistently had the most negative value in all cities for all years.

II.2   The history of Blacks and Hispanics in Durham and New Haven

Durham and New Haven were selected for this case study because of their similar tract-wide characteristics and contrasting history of racial integration. Durham and New Haven are both college towns with similar median income and a relatively large Black population. However, the two cities greatly differ in their legacy of racial integration.

Durham has a long history African American culture that traces back to the ages of the antebellum South (African American Heritage 2014). Parrish Street in downtown Durham was known as the "Black Wall Street" throughout the early 20th century because of its thriving African American businesses, and was praised as the nation's hub for Black entrepreneurship (McKinley 2006). Even during times of immense racial discrimination, Durham's African Americans were relatively well-integrated with the White community. New Haven, on the other hand, has a shorter history of Black communities and racial integration. The first African Americans settled in New Haven only after World War I. Moreover, unlike Durham's prosperous Black community, New Haven's African Americans suffered from economic decline and segregation until the 1990s (Sutherland 1992). The prominence of the African American race in Durham is also evident in an economic context, as the percentage of Black-owned

firms in Durham (25.9%) is higher than that of New Haven (15.3%) according to the 2007 U.S. Census Report.

While Durham is known for its well-established African American heritage, New Haven has a longer history of Latino presence in its communities. Hispanic immigrants have established themselves in New Haven since World War II, and have formed large ethnic communities in certain parts of town. The Hill area of New Haven, for example, used to be populated in the 1900s largely by the Irish and Germans, who were replaced after the 20th century by Eastern Europeans and Italians. Today, this region is largely dominated by Hispanics, with 50.5% of the area being inhabited by Latinos. With the increasing urbanization of New Haven, the influx of Hispanics has also greatly risen (Esposito 1989). Unlike northeastern cities like New Haven, southern cities like Durham have a relatively short history of Hispanic immigration. The Hispanic diaspora into the Raleigh-Durham metropolitan area began only after the Research Triangle Park's tech boom in the early 1990s. The first Hispanic immigrants came to Durham in the form of low-skilled workers in the late 1980s (Flippen and Parrado 2012). Although the number of Hispanics in Durham has greatly increased, they have only formed small pockets of Hispanic-dominated apartment complexes rather than sizable, established Latino communities (Flipen and Parrado 2012). As such, Blacks are well established in Durham whereas Hispanics have more prominent settlements in New Haven.

III.   Data

III.1   Home Mortgage Disclosure Act (HMDA) data

This paper examines HMDA data on home purchase loans in Durham and New Haven for the years 2007-2013. HMDA data is publicly available and is the primary data source for most studies on the mortgage market.

HMDA provides information on the type of loan (conventional or federally insured), purpose of the loan (home purchase, home improvement, refinance, multifamily dwelling), dollar amount of the loan, census tract where the house securing the loan is located, whether loan application was approved or denied, and the mortgage rate on the loan if the loan was originated. HMDA also reports data on the applicant's income, gender, race, and mortgage lender. In order to standardize the data pool, this study uses HMDA data for the years 2007-2013 on mortgages for one-to-four family dwellings that are owner-occupied and secured by first lien. Borrowers' characteristics such as income level, loan amount and race are used as independent variables in this study's regressions. Race indicator variables are created for American Indian or Alaska Native (AIAN), Asian, Pacific Islander (Pacifc), Black, Hispanic, Other and non-Hispanic White (White). This study categorizes Black to include both non-Hispanic and Hispanic Blacks, and classifies Hispanic to include non-White Hispanics and White Hispanics. Whites are only non-Hispanic Whites.

HMDA data have some limitations in that they do not provide information on the credit quality of each borrower. The data include very few items that directly pertain to the credit risk of each applicant. HMDA data also do not include information about the standards lenders use to evaluate credit or calculate loan prices. Past studies have supplemented HMDA data with proprietary information on individual credit history. While this study does not incorporate private information, it uses debt-to-income ratio (DTI) as a proxy for an

applicant's income level and level of indebtedness, which are the primary factors that determine credit risk.

In order to eliminate systematic outliers, certain mortgages were excluded from the dataset. For Durham, mortgage loans originated by the Self Help Credit Union (SHCU) were not included in the analysis. SHCU is a nonprofit organization subsidized by grants, religious organizations and government sources that offers financing for low-income households. Since SHCU is systematically different from all other lenders in its business model and low emphasis on income as a credit risk factor, it was excluded from the dataset. In the case of tobit regressions, minority groups with extremely small populations such as AlAN and Pacific Islander were combined with the Other races in order to avoid issues of multicollinearity.

A mortgage rate is determined by the benchmark rate and an additional interest rate that is added to the prime rate. This additional rate is called the rate spread. HMDA only reports mortgages whose spreads over the benchmark rate are greater than 1.5%. One crucial point to consider is the definition of a subprime loan. To compensate for the higher riskiness of borrowers with low credit quality, subprime mortgages charge interest rates at a large spread over the prime lending rate. However, HMDA does not specifically identify subprime loans. In order to determine whether a mortgage is subprime, past studies have relied on the HUD's list of lenders that specialize in the subprime market to determine subprime loans. This method may result in measurement error due to the omission of smaller lenders that do not report under HMDA. Furthermore, the HUD's subprime lender list was discontinued in 2005. Therefore, this study considers all mortgages categorized to be high-price loans as subprime loans. HMDA defines high-price loans to be loans with rates more than 1.5% above the prime rate. Therefore, high-price loans are used as a proxy for subprime loans for this study. For non-subprime loans whose rate spreads are not reported in the HMDA data, we

assume a spread of 0%. The tobit model discussed in Section III corrects for this censored mortgage rate data on non-subprime loans. Subprime loans should be associated with objective credit risk factors that justify the higher interest rates. If race is found to be a determinant of subprime lending even after controlling for proper credit risk measures such as debt-to-income ratio, it could be concluded that certain demographics were unfairly targeted for these high-cost loans.

Figure 1 and Table 1 show the average mortgage rate spread by race and annual benchmark mortgage rates for the years 2007-2013 in Durham and New Haven. The benchmark is the contract rate on a 30-year, fixed rate conventional mortgage as reported by Freddie Mac. As seen in Figure 1, the magnitude of the rate spreads between the two cities show a clear difference before and after 2010. Prior to 2010, all races in Durham face smaller spreads than those in New Haven. After 2010, however, borrowers in Durham receive larger spreads than those in New Haven.

The difference in spreads among the races also shows a clear trend before and after 2010. The spread gap between minorities and Whites drastically decline from 2007 to 2010 for both cities, which is an expected consequence of the mortgage market reforms and decline in risky lending after the financial crisis. After 2010, the minority-White gap shows a slight increase. There is a notable difference in the pattern of this increase between Durham and New Haven. In Durham, the Black-White gap increases but becomes much smaller than the Hispanic-White gap. On the other hand, the Black- and Hispanic-White gaps in New Haven increase to similar levels. In other words, Durham Blacks face a much lower rate spread than Hispanics while New Haven Blacks receive a higher or equal rate spread as Hispanics. Looking at the rate spread distribution by race alone does not prove the existence of racial bias, as we have yet to control for credit risk factors such as income and debt levels by race. Nonetheless, such

overview provides helpful insight into the difference in the magnitude and racial gaps in rate spreads between the two cities.

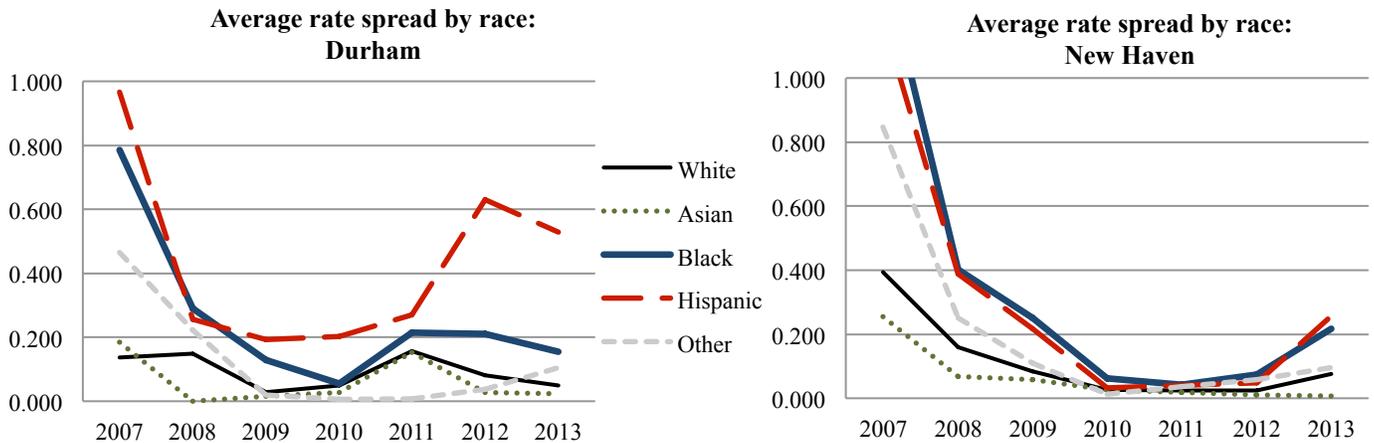FIGURE 1. Average annual rate spread by race

Average rate spread by race: Durham

Average rate spread by race: New Haven

Legend: White, Asian, Black, Hispanic, Other

TABLE 1. Average annual rate spread by race and mortgage benchmark rate (%)

	2007		2008		2009		2010	
	Durham	NH	Durham	NH	Durham	NH	Durham	NH
White	0.137	0.394	0.149	0.159	0.028	0.083	0.050	0.026
Asian	0.184	0.255	0.000	0.068	0.015	0.058	0.028	0.026
Black	0.785	1.368	0.290	0.402	0.129	0.251	0.055	0.063
Hispanic	0.966	1.182	0.256	0.388	0.193	0.218	0.202	0.033
AIAN	0.866	1.741	0.370	0.000	0.441	0.000	0.000	0.000
Pacific	0.000	1.148	0.000	0.246	0.000	0.000	0.000	0.000
Other	0.466	0.846	0.222	0.252	0.020	0.110	0.006	0.013
All races	0.362	0.585	0.187	0.198	0.054	0.104	0.054	0.028
Benchmark*	6.34		6.04		5.04		4.69	
	2011		2012		2013		All years	
	Durham	NH	Durham	NH	Durham	NH	Durham	NH
White	0.157	0.024	0.082	0.024	0.049	0.075	0.093	0.124
Asian	0.153	0.018	0.028	0.010	0.024	0.007	0.064	0.068
Black	0.214	0.041	0.210	0.073	0.154	0.217	0.318	0.509
Hispanic	0.269	0.041	0.631	0.049	0.529	0.258	0.492	0.409
AIAN	0.207	0.000	0.161	0.121	0.408	0.000	0.385	0.398
Pacific	0.714	0.000	0.364	0.000	0.474	0.110	0.148	0.257
Other	0.007	0.035	0.037	0.057	0.104	0.097	0.169	0.241
All races	0.156	0.027	0.128	0.031	0.097	0.094	0.164	0.177
Benchmark*	4.46		3.66		3.98		4.17	

*Contract rate on 30-year, fixed rate conventional home mortgages. Source: Freddie Mac

III.2   Office of the Comptroller of the Currency (OCC) list of lenders

This study employs probit and tobit regressions that distinguish between the behaviors of national and non-national (local) lenders. A list of the United States' largest lenders is used to create an indicator variable that shows if the mortgage is issued by a national or local lender. The list of active national lenders is updated regularly on the OCC website. Among the 100 largest banks with at least $10 billion worth of deposits, 95 national lenders were determined to be mortgage lenders that operate in all regions of the United States without being restricted to less than 5 states. All other lenders were categorized as local lenders and were given a value of 1 for the Local Lender indicator variable. Table 2 presents the top 10 among the 95 total institutions defined as national lenders in this study. Appendix 1 shows the full list of lenders categorized as national lenders in this study.

TABLE 2. Top 10 national mortgage lenders		
HMDA Name	HMDA Code	Charter No.
JPMorgan Chase Bank	13-4994650	8
Bank of America	57-0236115	13044
Wells Fargo Bank	94-1347393	1741
Citibank	13-5266470	1461
U.S. Bank	31-0841368	24
Quicken Loans	38-2603955	7197000003
PHH Mortgage	20-2031771	2317700005
PennyMac	26-2049351	26-2049351
Flagstar Bank	38-2734984	8412
Nationstar	75-2921540	75-2921540
The Bank of New York Mellon	13-5160382	541101

III.3   U.S. Census statistics: median income and racial composition

To supplement the HMDA loan data, this study also examines U.S. Census tract-level information to acquire qualitative insight on income distribution and racial composition. An overview of Census statistics for Durham and New Haven provides valuable context before delving into the HMDA data.

Figure 2 and Table 3 present the inflation-adjusted median income by race. Table 4 reports each race group's percentage of total population for the two cities. The median income is adjusted using the 2013 Consumer Price Index. All data are from the years 2000 and 2008-2013.

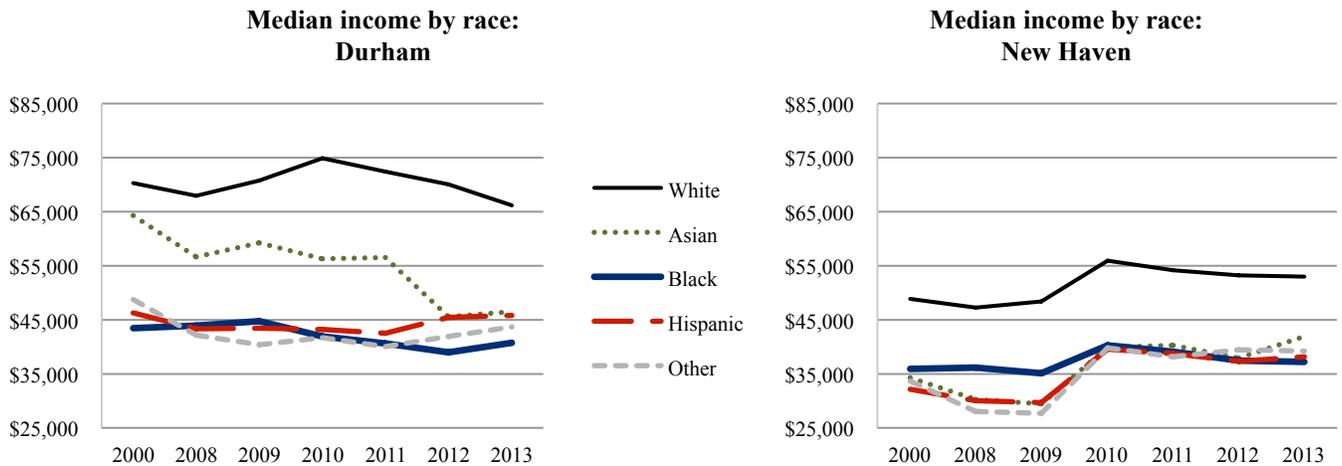FIGURE 2. Inflation-adjusted median income by race

TABLE 3. Inflation-adjusted median income by race (2013 CPI)

	2000		2008		2009		2010	
	Durham	NH	Durham	NH	Durham	NH	Durham	NH
White	$ 70,313	$ 48,803	$ 67,988	$ 47,248	$ 70,732	$ 48,340	$ 74,881	$ 55,912
Asian	$ 64,251	$ 34,233	$ 56,660	$ 30,290	$ 59,187	$ 29,435	$ 56,274	$ 39,866
Black	$ 43,387	$ 35,851	$ 43,881	$ 36,151	$ 44,723	$ 35,100	$ 41,899	$ 40,275
Hispanic	$ 46,328	$ 32,168	$ 43,367	$ 29,975	$ 43,502	$ 29,652	$ 43,190	$ 39,582
Other	$ 48,692	$ 33,679	$ 42,098	$ 28,031	$ 40,442	$ 27,692	$ 41,693	$ 39,803
All races	$ 56,506	$ 40,636	$ 54,499	$ 37,975	$ 57,065	$ 37,720	$ 55,410	$ 45,607

	2011		2012		2013	
	Durham	NH	Durham	NH	Durham	NH
White	$ 72,400	$ 54,168	$ 70,017	$ 53,228	$ 66,135	$ 53,033
Asian	$ 56,538	$ 40,232	$ 45,554	$ 37,884	$ 46,517	$ 41,931
Black	$ 40,599	$ 39,067	$ 38,922	$ 37,382	$ 40,776	$ 37,258
Hispanic	$ 42,446	$ 38,786	$ 45,473	$ 37,350	$ 45,828	$ 38,179
Other	$ 39,981	$ 38,144	$ 41,886	$ 39,490	$ 43,719	$ 39,215
All races	$ 53,720	$ 44,191	$ 51,634	$ 43,539	$ 51,941	$ 43,242

Overall, the median income is higher in Durham than in New Haven for all races. However, the change in median income by race throughout the years reflects the shift in the socioeconomic state of Blacks and Hispanics in the two cities. In Durham, Hispanics have lower median incomes than Blacks in the years 2008 and 2009. However, Hispanics see a consistent increase in income throughout the years and eventually surpass the income level of Blacks in 2010. In the years since 2010, Hispanics become the race group with the third-highest median income, after Whites and Asians. In New Haven, Hispanics do not experience the same increase in income. Blacks in New Haven have consistently higher levels of income than Hispanics throughout the years, although the median incomes of all non-White races reach comparable levels since 2010. Such trends are clearly observable in Figure 2, which graphically charts the change in inflation-adjusted median income.

TABLE 4. Race % of total population

	2000		2008		2009		2010	
	Durham	NH	Durham	NH	Durham	NH	Durham	NH
White	43.3%	35.6%	41.4%	32.4%	44.8%	32.2%	39.3%	32.0%
Asian	3.6%	4.0%	4.5%	4.6%	4.3%	4.7%	5.0%	4.6%
Black	43.0%	37.4%	42.6%	37.7%	40.3%	37.8%	40.0%	35.4%
Hispanic	8.5%	21.4%	10.4%	26.0%	9.7%	26.7%	14.5%	27.4%
Other	6.9%	15.2%	8.1%	17.6%	7.7%	17.9%	8.5%	13.0%

	2011		2012		2013	
	Durham	NH	Durham	NH	Durham	NH
White	39.2%	31.8%	35.8%	30.1%	37.2%	29.3%
Asian	4.9%	4.7%	5.5%	4.9%	4.6%	5.1%
Black	39.8%	35.3%	40.9%	36.2%	39.8%	36.0%
Hispanic	14.9%	28.1%	15.4%	30.1%	16.0%	30.1%
Other	8.7%	13.4%	9.1%	13.7%	7.0%	13.6%

The percentage by race throughout the years also offers insight into the racial landscape of the two cities. In both Durham and New Haven, Whites show

a consistent decrease in their share of the total population. The Black portion of the population noticeably decreases in Durham from 43% in 2000 to 39.8% in 2013, but stays consistent in New Haven at around 37%. The most apparent trend is the increase in the Hispanic population for both cities. Hispanics see a consistent increase in their share of the total population in New Haven from 21.4% in 2000 to 30.1% in 2013. Durham's share of the Hispanic population also increases rapidly from 8.5% in 2000 to 16% in 2013, but the trend is more volatile with a drop to 9.7% in 2009 followed by a sharp increase to 14.5% in 2010. In 2010, the share of the Hispanic population in New Haven was already high at 27.4%, compared to the 14.5% in Durham. Despite the large increase in Hispanic residents, the racial composition of Durham is still dominated by Whites and Blacks, with the combination of both races consisting almost 40% of the entire population, New Haven shows a more even divide among Whites, Blacks, and Hispanics, with each race composing around 30% of the total population.

III.4   Income disparity: the probability of living in a poor tract by race

It may be valuable to test the income distribution by race to quantify the degree of racial income inequality in the two cities. A simple probit regression is conducted as such for each city:

$$PoorTract = \beta_0 + \beta_1 DTI_i + \beta_{2i}\, Race_i + u_i$$

The dependent variable PoorTract is a dummy variable that indicates whether a tract is a poverty area. The definition of poverty area comes from the 2000 U.S. Census. The independent variable DTI_i is the debt-to-income ratio of borrower i. $Race_i$ are dummy variables that indicate the race of the borrower i: American Indian or Alaska Native (AIAN), Asian, Pacific Islander (Pacific), Black, Hispanic, White and Other. The White race variable is omitted. The regression is conducted on 2007-2013 HMDA mortgage data for Durham and New Haven. Table 3 presents the probit regression results.

TABLE 3. Tract Poverty and Race Model

Variables	Dependent Variable: PoorTract	
Omitted: White	Durham	New Haven
DTI	-0.116	-0.043
	(0.019)***	(0.011)***
AIAN	0.072	0.670
	(0.309)	(0.164)***
Asian	-0.246	0.244
	(0.119)**	(0.055)***
Pacific	0.492	0.574
	(0.249)**	(0.152)***
Black	0.271	1.065
	(0.045)***	(0.030)***
Hispanic	0.229	0.856
	(0.078)***	(0.029)***
Other	0.095	0.243
	(0.061)	(0.036)***
Constant	-1.717	-1.884
	(0.052)	(0.032)***
Pseudo R2	0.017	0.104

Significance: *10% **5% ***1%

Bold = significant with expected/plausible signs

The regression results show that a borrower being a non-White race increases the likelihood that he belongs to a poor tract at a statistically significant level. The magnitude of the increase in likelihood, however, is much greater in New Haven than in Durham. Looking at the marginal effects of each race on the odds of living in a poverty tract, this is true especially for Blacks. The probability of Durham Blacks belonging in a poverty tract is higher than that of Whites by only 1.6%, whereas in New Haven a Black resident is 9.1% more likely than a White person to live in a poor tract. The marginal effect of Hispanics is also very different between the two cities. Durham Hispanics are 1.4% more likely than Whites to live in a poor tract, while New Haven Hispanics are 7.3% more likely. Similarly, Durham Asians are actually 0.7% less likely than Whites to live in a

poverty tract while New Haven Asians are 2.1% more likely to belong in a poor neighborhood. From these results, it seems that non-White races in New Haven are significantly more likely to live in poor neighborhoods than Whites.

Considering that the prosperity of a neighborhood reflects the personal income level of its residents, the income disparity between Whites and non-Whites seems to be greater in New Haven than in Durham. Furthermore, all minorities in New Haven are more likely to live in a poor neighborhood than Whites whereas Asians in Durham are actually less likely than Whites to live in a poor tract. This is consistent with the U.S. Census data that minorities in New Haven have more comparable income levels to one another, unlike Durham where the White and Asian races have significantly higher incomes than other minorities.

IV.   Theoretical Framework

IV.1   The significance of race variables

The most widely tested theory on racial discrepancy in the mortgage market is that the minority race variables are significant and positively correlated with the subprime mortgage rate or the likelihood of getting a subprime mortgage. Indeed, it has been shown in past studies that the minority race variables, especially the African American variable, are positively correlated with the probability of getting a subprime mortgage or larger mortgage rate spread. The Black variable has been found to be the most statistically significant among the minority dummy variables. For example, a study by DeLoughy in 2010 regressed the probability of a subprime loan against race variables, and concluded that the African American dummy variable coefficient is consistently significant and positive even after controlling for neighborhood, individual and property risk measures. Based on the findings thus far on racial disparities in the mortgage

market, this study should also find that the Black dummy variable has a positive and statistically significant coefficient.

The theory, however, is not perfectly conclusive. Due to the lack of publicly available individual credit risk information, many models in the past have had difficulty controlling for borrower-related risk factors like credit score, employment history and non-mortgage indebtedness (Canner et al. 1999). The lack of measure for individual applicant credit worthiness is a major limitation in the use of HMDA data. The measures of risk that are constructed from available data serve as proxies for the real risks faced by mortgage lenders.

This study addresses the above issue by including a proxy for borrower's credit quality and using the tobit model to account for the missing data. The proxy for a borrower's credit quality is the debt-to-income ratio (DTI), which is calculated by dividing the borrower's mortgage loan amount by personal income. All of this information is reported in the HMDA data. This measure does not account for non-mortgage debt such as car loans or student loans. However, DTI serves as the appropriate proxy under the assumption that real estate is the largest source of debt for most households. Furthermore, this study uses tobit regressions to account for censored information in the mortgage rate data. The regression models are further discussed later in this section.

IV.2 Distinction between objective risk measures and local lending culture

In this paper, the methodology used to determine racial bias in the mortgage market is examining the behavior of local lenders towards borrower-level attributes, controlling for the behavior of national lenders. This paper assumes that a mortgage lender considers two main components when reaching a lending decision: objective risk measures and the local lending culture. Objective risk measures are legitimate factors considered when assessing an individual's riskiness, such as income, loan amount and DTI ratio. Risk measures may also

include complications that are inherent in the borrower's race or neighborhood, one example being spillover effects. Spillover effects are discussed in greater detail later in this section.

Local lending culture, on the other hand, is a subjective measure of risk such as a psychological bias towards certain race groups. Such attitude towards racial risk is strongly influenced and molded by the local history of racial legacy and degree of integration. This study assumes that national lenders take into account all risk measures that are not driven by the local lending culture. National lenders face the same spillover effects and borrower attributes as local lenders, but they originate their mortgages from a national corporate office that abides by standardized lending criteria across all cities. National lenders therefore do not reflect the racial attitude that is unique to a particular city. National lenders hence control for non-local risk factors, allowing us to recover the effect of local lending criteria. The difference in lending patterns between national lenders and local lenders reveals some aspects of the local lending culture regarding race perception, which could be a result of different urban histories of racial integration. Therefore, this study incorporates a local lender indicator in its regressions to determine the presence of local racial bias among mortgage lenders.

IV.3   Tobit regression correcting for censored mortgage data

As mentioned in Section III, HMDA does not report mortgages rate values with rate spreads that are less than 1.5%. This censored part of the data distribution needs to be accounted for, which can be accomplished by using the tobit regression. The tobit model, also called a censored regression model, estimates linear relationships between variables when there is either left- or right-censoring in the dependent variable. Right-censoring takes place when there exists an upper limit such that values that go above a certain threshold are unobserved. In the case of left-censoring, values that fall below a certain threshold

are censored. In the HMDA data, left-censoring occurs because rate spreads that fall below 1.5% are not reported. A detailed discussion of the tobit regression is presented in Section V.

IV.4   Spillover effects of residential segregation

Spillover effects resulting from the geographic segregation of races are an implication that must be considered in this study. If a certain race is perceived to be riskier based on objective credit risk measures and/or subjective racial bias, neighborhoods that are predominantly inhabited by that race may be systematically subject to higher mortgage rates. For example, individuals of the Black race may generally have lower income than others, which makes leads them to have higher credit risk. If neighborhoods are very segregated, Blacks will tend to live in racially homogenous neighborhoods. If many Blacks tend to have low credit quality and tend to cluster together in adjacent communities, the presence of low-credit Blacks may put their predominantly Black neighborhood at the risk of higher default rates and low housing prices. Consequently, even Black borrowers with good credit quality may come to face the default risk and low home value of the entire community, resulting in systematically higher mortgage rates regardless of their individual credit quality. The general riskiness of the members of a race can therefore spill over to an entire community predominantly inhabited by that race.

IV.5   Racial segregation indices

Quantitative measures of geographical segregation are the University of Michigan Population Studies Center's segregation indices. The first index is the Dissimilarity Index calculated based on the 2000 Census data. The Dissimilarity Index is the most commonly used measure of segregation, and it shows the degree to which a non-White race is distributed away from Whites across census tracts.

The value of the index ranges from 0, indicating complete integration, to 100, indicating complete segregation. For example, if a city's White-Black Dissimilarity Index is 65, it means that 65% of White people would need to move to another neighborhood to make Whites and Blacks evenly distributed across all tracts such that the index attains a value of 0. A detailed calculation of the Segregation Index is provided in Appendix 2. Table 4 shows the index values for all races in Durham and New Haven. Figure 2 highlights the dissimilarity indices for Asians, Blacks and Hispanics.

	TABLE. Racial Segregation Index for Durham and New Haven (2000 U.S. Census)					
	Dissimilarity index with whites		Total population		% of total population	
	Durham	New Haven	Durham	New Haven	Durham	New Haven
White	--	--	79,277	43,979	42.39%	35.57%
AIAN	36.4	37.7	455	348	0.24%	0.28%
Asian	36.7	42.6	6,782	4,776	3.63%	3.86%
Pacific	78.4	71	58	47	0.03%	0.04%
Black	54.3	48.5	81,370	44,598	43.51%	36.07%
Hispanic	57.4	49.4	16,012	26,443	8.56%	21.39%
Other	44.7	53	3,081	3,435	1.64%	2.79%
Total	--	--	187,035	123,626	100.00%	100.00%

According to the Dissimilarity Index, the segregation between non-White races and Whites is greater in Durham than New Haven. Regarding the degree of White-Black segregation, Durham has a higher value of 54.3 compared to New Haven's dissimilarity score of 48.5. Regarding the White-Hispanic segregation, Durham also has a greater segregation value of 57.4 than New Haven's 49.4. The result is surprising because this study initially expected Durham to have a better integration of Blacks with the White race. Considering the longer history of Hispanic migration into New Haven, it is also surprising that New Haven's White-Hispanic geographic dissimilarity is greater than the White-Black gap. Contrary to expectation, a long-established Black or Hispanic heritage in the two
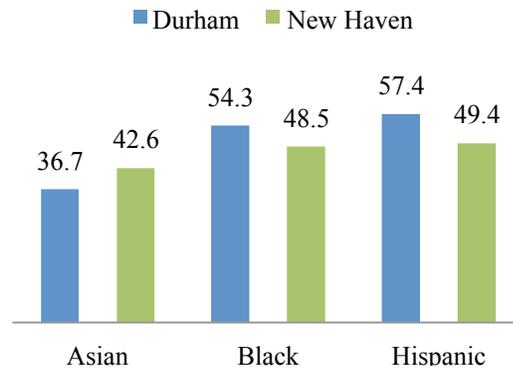
cities seems to lead such races to further isolate themselves from Whites rather than becoming better integrated with them.

FIGURE 2.
Dissimilarity Index for Durham and New

■ Durham ■ New Haven

Asian: 36.7, 42.6
Black: 54.3, 48.5
Hispanic: 57.4, 49.4

The second index is the Exposure Index. The Exposure Index shows how closely certain racial groups tend to live with each other within a tract. Unlike the Dissimilarity Index that looks at how evenly all races are distributed across all tracts in a city, the Exposure Index determines what the typical racial composition is within a single tract. For example, the Exposure Index for Blacks gives the percentage of the total tract population that is White, Asian, or Hispanic in the neighborhood of a typical Black person. Table 5 presents the Exposure Index for Durham and New Haven.

According to the Exposure Index, Blacks in Durham tend to live closer to other Blacks and Whites, whereas Blacks in New Haven tend to live in a more racially diverse tract. The average percentage of Blacks in a tract inhabited by a typical Black person in Durham is 62.4%, while the number is much lower at 54.6% in New Haven. On the other hand, Hispanics in New Haven tend to be more clustered together than those in Durham. The average percentage of Hispanics in a typical tract occupied by a Hispanic in New Haven in 37.7%, which is much higher than Durham's 20.3%. This result is consistent with the fact that New Haven has large, well-established Latino communities. Another way view these index values is that Blacks are the dominant minority race in Durham while Hispanics have a noticeably large community in New Haven. In Durham, the average share of Blacks in a typical tract is 43.5%, which is much larger than the share of all other minority races. In New Haven, the average share of

Hispanics in a typical tract is 21.4%, which is smaller but highly comparable to the 36.1% share of Blacks.

TABLE 5. Exposure Index (2010 U.S. Census)							
Durham, NC							
	White	Asian	Black	Hispanic	AIAN	Pacific	Other
White	63.10%	4.60%	24.90%	5.50%	0.20%	0.00%	0.20%
Asian	53.50%	9.50%	27.20%	7.30%	0.30%	0.00%	0.20%
Black	24.20%	2.30%	62.40%	9.40%	0.30%	0.00%	0.20%
Hispanic	27.00%	3.10%	47.70%	20.30%	0.30%	0.00%	0.20%
AIAN	40.40%	3.70%	44.40%	9.30%	0.40%	0.00%	0.20%
Average	42.40%	3.60%	43.50%	8.60%	0.20%	0.00%	0.20%
New Haven, CT							
White	56.10%	5.70%	20.80%	14.40%	0.20%	0.10%	0.40%
Asian	52.70%	14.10%	18.70%	10.90%	0.30%	0.10%	0.40%
Black	20.50%	2.00%	54.60%	19.80%	0.30%	0.00%	0.30%
Hispanic	24.00%	2.00%	33.30%	37.70%	0.30%	0.00%	0.30%
AIAN	30.50%	3.80%	42.50%	19.50%	0.70%	0.10%	0.30%
Average	35.60%	3.90%	36.10%	21.40%	0.30%	0.00%	0.30%

The combined analysis of Census tract-level data and the Poor Tract regression provides useful perspective on the racial and socioeconomic environments of Durham and New Haven. The Dissimilarity Index indicates that Durham has a greater degree of geographic segregation among minorities, especially for Blacks. The Exposure Index points that Blacks are the dominant minority group in Durham, whereas the Hispanic community is much better established in New Haven. These findings provide interesting implications for the interpretation of this study's empirical results. Durham's greater degree of geographic segregation is likely to amplify the spillover effect on Black borrowers, especially since the Census data indicate that Blacks in Durham have lower income levels than other races. However, the dominance of African Americans in Durham may foster more favorable attitudes towards Black borrowers, which could offset the negative effect of spillovers in racially homogenous neighborhoods. New Haven's higher degree of geographic integration could translate into less racial bias and spillover risk, which could

offset the negative effect of lower income levels in its minorities that is observed in the Poor Tract regression. The following empirical analysis of HDMA data will show which conclusion holds true.

V. Empirical Specification

V.1 Tobit model with Borrower Attributes

Before progressing to more complex regressions, we first conduct a simple tobit regression of mortgage rate spread on basic borrower attributes, without the local lender and interaction variables. The model is as follows:

$$Spread_i = \beta_0 + \beta_1\, DTI_i + \beta_{2j}\, Race_{ij} + Years + Tracts + u_i$$

The dependent variable Spread is the rate spread of borrower i's mortgage loan. The independent variables are the borrower attributes including borrower i's DTI ratio (DTI_i) and race indicator ($Race_{ij}$). *Years* and *Tracts* capture the fixed effects. Table 6 summarizes the regression variables and Table 7 shows the regression results.

TABLE 6. Borrower Attributes tobit model variables	
Dependent variable	
Spread	Mortgage rate spread
Independent variables	
DTI	Debt-to-income ratio = Mortgage loan amount / Borrower's income
AIAN	Dummy variable for American Indian/Alaska Native borrower
Asian	Dummy variable for Asian borrower
Black	Dummy variable for Black borrower
Hispanic	Dummy variable for Hispanic borrower
Other	Dummy variable for other/unknown race borrower
Years	Dummy variables for 2007, 2008, 2009, 2010, 2011, 2012, 2013
Tracts	Dummy variables for all tracts in Durham or New Haven

TABLE 7. Borrower Attributes tobit model		
Variables	Dependent Variable: Subprime	
Omitted: White	Durham	New Haven
DTI	0.010	-0.049
	(0.020)	(0.048)
AIAN	1.659	1.076
	(1.006)*	(0.843)
Asian	-0.623	-1.121
	(0.488)^	(0.332)***
Pacific	0.126	0.529
	(1.222)	(0.823)
Black	2.009	1.579
	(0.201)***	(0.159)***
Hispanic	3.155	1.238
	(0.279)***	(0.147)***
Other	0.400	1.012
	(0.268)	(0.151)
Constant	-4.861	-3.012
	(1.335)***	(1.369)***
Pseudo R2	0.069	0.127

Significance: ^ 20% *10% **5% ***1%
Controlled for year and tract fixed effects

The White variable is omitted such that all coefficient values for each race are relative to the White race. Controlling for DTI ratio, which we use as a proxy for an individual's creditworthiness, the Black and Hispanic variables are both significant predictors of a higher rate spread. Asians receive lower spreads in both cities, although at a more significant level in New Haven than in Durham. Looking at marginal effects, Black and Hispanic borrowers in New Haven receive larger rate spreads than Whites. Their magnitudes are similar, with Blacks and Hispanics receiving rate spreads that are 1.2% and 1.6% higher than Whites, respectively. In Durham, however, Hispanics receive a much higher spread of 3.16% compared to Blacks who receive a spread of 2% over Whites. This simple regression gives a rough outline of how lender attitudes towards borrower risk measures and races differ between the two counties. Despite its well-established African American heritage, the Durham mortgage market charges higher spread

to minorities than in New Haven. In Durham, Hispanics receive the largest rate spread whereas in New Haven, African Americans receive the highest mortgage rate spread.

V.2 Tobit model with Local Lender effect

The second model in this paper is a tobit regression of mortgage rate spread on borrower attributes, a local lender indicator variable, and borrower and local lender interaction variables. The regression also controls for year and tract fixed effects. The model is as follows:

$$Spread_i = \beta_0 + \beta_1 \, DTI_i + \beta_2 \, Race_{ij} + \beta_3 \, Local_i$$
$$+ \beta_3 \, Local_i*DTI_i + \beta_{4j} \, Local_i*Race_{ij} + Years + Tracts + u_i$$

Spread, *DTI* and *Race* variables are identical as in the Borrower Attributes model. *Local* is the dummy variable indicating whether the lender that issued borrower *i*'s mortgage is a local or national entity. As mentioned in Section III, local lenders are determined based on the OCC list of national lenders. *Local* takes the value of 1 if the lender is a local lender, and a value of 0 if the lender is a national lender. The *Local_i*DTI_i* and *Local_i*Race_{ij}* variables are the interaction terms that show the local lender's response to the borrower's DTI ratio and race on the rate spread. Borrower attributes that are not interacted with the Local Lender dummy are the national lender's decision on the rate spread given the borrower's DTI and race. The *Years* and *Tracts* are dummy variables that represent the year and tract in which the mortgage was issued. These fixed effect variables control for the variance inherent in years and census tracts. The variables are defined in Table 8 and the Local Lender Effect tobit results are presented in Table 9.

TABLE 8. Local Lender Effect tobit model

Dependent variable	
Spread	Mortgage rate spread

Independent variables	
DTI	Debt-to-income ratio = Mortgage loan amount / Borrower's income
Asian	Dummy variable for Asian borrower
Black	Dummy variable for Black borrower
Hispanic	Dummy variable for Hispanic borrower
Other	Dummy variable for other/unknown race borrower
Local	Dummy variable for local lender
LocDTI	Local * DTI
LocAsian	Local * Asian
LocBlack	Local * Black
LocHispanic	Local * Hispanic
LocOther	Local * Other
Years	Dummy variables for 2007, 2008, 2009, 2010, 2011, 2012, 2013
Tracts	Dummy variables for all tracts in Durham or New Haven

TABLE 9. Local Lender Effect tobit model

Dependent Variable: Spread

	Durham	New Haven		Durham	New Haven
DTI	-0.245	0.228	LocDTI	0.257	-0.358
	(0.202)	(0.108)**		(0.203)	(0.120)***
Asian	-1.534	-1.642	LocAsian	0.991	0.784
	(1.661)	(0.695)**		(1.737)	(0.786)
Black	2.546	1.110	LocBlack	-0.643	0.556
	(0.446)***	(0.327)***		(0.475)^	(0.354)^
Hispanic	1.749	0.166	LocHispanic	1.515	1.270
	(0.826)**	(0.342)		(0.867)*	(0.369)***
Other	0.930	-0.213	LocOther	-0.636	1.558
	(0.642)^	(0.347)		(0.699)	(0.383)***
			Local	1.329	1.837
				(0.607)**	(0.364)***
Constant	-5.507	-4.399			
	(1.446)***	(1.377)***			
Pseudo R2	0.076	0.133			

Significance: ^ 20% *10% **5% ***1%

Controlled for year and tract fixed effects

Controlling for local lender effects, the significance of the DTI variable drastically increases for New Haven, while it remains an insignificant predictor of mortgage rate spreads for Durham. The Local indicator variable is significant and positive for both cities, indicating that local lenders tend to charge higher spreads to minorities than Whites. The Black variable, which represents the national lender's response to a Black applicant, remains a significant and positive predictor of rate spreads in both cities. Despite the fact that Blacks in Durham have a higher median income than those in New Haven, national lenders still charge higher rates to Durham Blacks than New Haven Blacks. Looking at marginal effects, an average Black borrower in Durham receives a spread that is 2.55% higher than that of Whites, while Blacks in New Haven receive a spread of only 1.11% over Whites. The same phenomenon is observable for national lenders' response to Hispanic borrowers. Despite the fact that Hispanics in Durham have higher income than those in New Haven, a typical national lender charges Durham Hispanics a rate spread of 1.75% over Whites, whereas it charges New Haven Hispanics a smaller spread of 0.17%.

As mentioned in our hypothesis, national lenders are supposed to identify general and legitimate risk factors that are not affected by local culture, including spillover risk and objective credit measures like borrower's income. According to our analysis of Census data and the Poor Tract regressions in Section III, it hence follows that national lenders should charge higher rates for minorities in New Haven than those in Durham. However, our Local Lender Effect tobit model shows the contrary. This result testifies that spillover effects may outweigh the objective credit measures when national lenders make lending decisions. It was seen in the Segregation Indices that Durham has a higher degree of Black and Hispanic segregation than New Haven. Even though Blacks and Hispanics in Durham have higher income and hence are more creditworthy than those in New Haven, Durham Blacks and Hispanics still have lower incomes relative to other

races within Durham and thus suffer from spillover effects due to their higher level of segregation. On the other hand, the spillover risk resulting from the racial homogeneity of neighborhoods is less of a factor in New Haven. As seen by the significance of the DTI variable for New Haven, objective credit measures surface as the determinant of risk when the effect of spillovers is small.

The Local Lender interaction variables perform well in this regression, producing some notable results. First, the Local Lender dummy variable proves to be a significant predictor of higher mortgage rates. The LocBlack variable, which is the local lenders' response to a Black mortgage applicant, is negative for Durham. Although LocBlack is significant only at the 20% level, its negative correlation with rate spread deviates from the highly positive Black race coefficients observed in past studies. LocBlack in Durham decreases the rate spread by 0.64%, whereas the LocBlack in New Haven increases the spread by 0.55%. This indicates that local lenders in Durham may show more favorable attitudes to Black applicants over Whites, as predicted in our hypothesis. In contrast, Durham's LocHispanic variable is a significant predictor of higher mortgage rate spreads. LocHispanic is a predictor of higher rates for New Haven as well, but with a slightly smaller magnitude. While LocHispanic in Durham increases the rate spread by 1.51%, the LocHispanic for New Haven increases the spread by 1.27%.

The local lender variables validate the hypothesis that local lenders may reflect less conventional attitudes towards certain minorities, especially Blacks. Local lenders tend to charge lower rates for Blacks in Durham than Blacks in New Haven. Although this estimate is not significant in the statistical sense, it is notable given its high contrast with the national lender's less favorable treatment of Durham Blacks. Meanwhile, local lenders charge lower rates to New Haven Hispanics at a statistically significant level. As seen by the insignificance of the LocDTI for Durham, objective credit measures seem to be outweighed by race

factors for local lenders in Durham. The DTI ratio is a significant factor for New Haven local lenders, but it indicates that higher levels of debt actually decreases the rate spread by 0.36%. At the local level, typical credit risk measures once again fail to be significant or accurate predictors of rate spreads. Instead, racial perception plays the dominant role in influencing lending decisions. Durham local lenders behave consistently with the fact that Blacks are the well-established, dominant minority in Durham, treating Black borrowers less harshly than national lenders. In contrast, Durham local lenders charge Hispanics higher mortgage spreads, despite the fact that Durham Hispanics have higher incomes than Blacks. Consistent with New Haven's longer legacy of Latino immigration, New Haven local lenders charge lower spreads to Hispanics than Durham local lenders.

National lenders charge larger rate spreads to Blacks than Hispanics, while local lenders charge higher rates to Hispanics than Blacks. Given the fact that Hispanics generally have higher income levels than Blacks, this confirms the validity of the Local Lender model. National lenders appropriately respond to legitimate risk measures like income level and spillover risk in that they charge higher rates to Blacks than Hispanics in both cities, especially in Durham where greater spillover effects exist. Local lenders show a deviation from this behavior by charging lower rates to Blacks than Hispanics in both cities, especially in Durham where Blacks have well-established communities. It seems that Hispanics are treated less favorably by local lenders in both cities despite their high level of income, especially in Durham. This could be a result of negative bias resulting from the short legacy of Hispanics in the U.S relative to other minorities.

V.3   Temporal variation probit model with Local Lender effect

Since the Dodd-Frank mortgage reform act was passed in July 2010, this study examines the changes in lending patterns resulting from the 2010 mortgage reforms. We run a temporal variation probit regression on data from pre- and

post-2010 reforms. Instead of running the probit regressions separately for Durham and New Haven, we now pool the data from the two cities and create a New Haven indicator variable to distinguish the effects between Durham and New Haven. This regression thereby observes the significance of the New Haven interaction variables, as well as any changes before and after the 2010 year cut-off. In order to avoid issues of multicollinearity that arises from adding the New Haven interaction variables, a probit model is chosen over a tobit model for the temporal variation analysis. In the probit model, the dependent variable is a dummy variable indicating a subprime mortgage. Therefore, the interpretation of the coefficients is now the probability of receiving a subprime mortgage, rather than the mortgage rate spread. Table 10 summarizes the definition and calculation of each variable. Table 11 presents the results from the probit regression on data from for pre-2010, post-2010 and all years (2007-2013). Marginal effects are discussed in the text but not included in the table.

Consistent with the intention of the mortgage market reforms to eradicate racial discrimination, the temporal variation regressions show a noticeable decline in significance for the race variables in the years after 2010. In the regression for pre-2010 years, the Black and Hispanic race variables for both Durham and New Haven are significant predictors of one's likelihood of getting a subprime mortgage. The results from this temporal variation probit is similar to those of the Local Lender effect tobit regression, but highlights the contrasting local racial perceptions between the two cities.

First, we look at the pre-2010 years. Before the 2010 reforms, race variables dominate over DTI measures as strong predictors of subprime probability. In Durham, national lenders are more likely to issue subprime loans to Blacks than Hispanics. According to marginal effects, Durham Blacks are 5.4% more likely to receive subprime loans than Whites while Hispanics are only 3.9% more likely to do so. For local lenders in Durham, on the other hand, Hispanics

38

are more likely to receive high-cost loans than Blacks. Durham local lenders are 4.12% more likely to issue subprime mortgages to Hispanics at a statistically significant level.

In New Haven, national lenders are less likely to give subprime loans to minorities than those in Durham, as seen by the negative *NH*Black* and *NH*Hispanic* coefficients. Looking at marginal effects, national lenders in New Haven are 3.26% less likely to issue subprime loans to Blacks than Durham, and 3.61% less likely to do so to Hispanics. This is consistent with the fact that minorities in New Haven face less spillover risk than Durham minorities. The behavior of local lenders is particularly interesting. The variable that is most noteworthy in this regression is *NH*LocBlack*, which is the response of New Haven local lenders to the Black race relative to the Durham local lenders. *NH*LocBlack* is a significant predictor of higher subprime probability such that local lenders in New Haven are 2.5% more likely to issue a subprime loan to a Black borrower than a local lender in Durham. This confirms the results from the Local lender tobit that local lenders in Durham show more favorable attitudes towards Blacks than local lenders in New Haven. This supports the study's hypothesis that Durham local lenders would show more favorable attitudes towards Blacks than national lenders or New Haven local lenders because of their African American legacy.

Now we look at the post-2010 years. After the 2010 reforms, all of the race variables lose their predictive power in both cities. This adequately shows that the mortgage reforms were effective in diminishing the significance of race as a determinant of credit risk. The most noteworthy variables in the post-2010 regression are the local lender indicators, *Local* and *NH*Local*. In contrast to the pre-2010 regression, the local lender indicator now becomes the most significant predictor of subprime likelihood. Prior to 2010, New Haven local lenders are 2.47% more likely to issue a subprime loan than Durham local lenders at the 20%

significance level. After the 2010 reforms, however, the relationship is reversed. In the post-2010 regression, a New Haven local lender is 15.2% less likely to issue a subprime loan than Durham local lenders at the 5% significance level. This reversal in the signs and significance of local lender indicators is consistent with the post-2010 reversal of rate spread magnitudes between the two cities that was seen in Section III.1. Despite their higher level of income, Durham borrowers become more likely to receive subprime loans than those in New Haven after the reforms.

The temporal variation probit provides robust results that confirm and reinforce our results from the Local Lender tobit model. The pre-2010 regressions highlight the significance of the race variables at both the national and local level. Before 2010, national lenders charge higher rates to Durham than New Haven minorities, especially Blacks. This may be the result of a greater emphasis on spillover risk following the financial crisis of 2008, when minority neighborhoods that predominantly held subprime loans experienced a large number of defaults and foreclosures. At the local level, lenders show strong response towards certain race groups. While New Haven local lenders charge higher rates to Blacks, Durham local lenders clearly issue more high-cost loans to Hispanics. This reflects the racial history and dynamics of the two regions, where Hispanics are better established in New Haven whereas Blacks have more dominance in Durham. The pre-reform regressions more evidently show the significance of race factors in the form of greater spillover risk for national lenders and in the form of psychological racial bias for local lenders. The regression results indicate that local lenders did act more favorably towards the race group with a longer legacy of integration into the overall community prior to the 2010 reforms.

It was observed in the Local Lender tobit model that national lenders are more likely to charge higher rates to Durham borrowers than New Haven residents, reflecting Durham's larger spillover risk that offset the high median

income. The temporal variation probit model makes it clear that this phenomenon persists even after the 2010 reforms. After 2010, national lenders do not emphasize any of the race factors or the DTI measure, but still charge Durham borrowers higher rates than New Haven loan applicants. Likewise at the local lenders charge higher rates to Durham than New Haven regardless of race. The diminished significance of the race variables testify that the 2010 reforms were quite effective in diminishing racialized risk. However, the persistence of higher mortgage rates in Durham throughout all years by national lenders suggest that Durham may have legitimate risk factors that are not captured by racial bias or traditional credit risk measures like DTI ratio. It is possible that such omitted risk factors include the high level of geographic segregation and spillover risk that is present in Durham. There could exist other risk factors inherent in Durham that is not explained by this study's model, which could explain why local lenders in Durham are significantly more likely to charge higher rates to its borrowers. Nonetheless, the persistence of more expensive loans in Durham despite its wealth level affirm that more complex risk factors like spillover are a real concern for mortgage lenders.

TABLE 10. Temporal variation, Local Lender Effect probit model	
Dependent variable	
Subprime	Dummy variable for subprime loan (loan with rate spread > 1.5%)
Independent variables	
DTI	Debt-to-income ratio = Mortgage loan amount / Borrower's income
AIAN	Dummy variable for American Indian/Alaska Native borrower
Asian	Dummy variable for Asian borrower
Black	Dummy variable for Black borrower
Hispanic	Dummy variable for Hispanic borrower
Other	Dummy variable for other/unknown race borrower
Local	Dummy variable for local lender
LocDTI	Local * DTI
LocAIAN	Local * AIAN
LocAsian	Local * Asian
LocBlack	Local * Black
LocHispanic	Local * Hispanic
LocOther	Local * Other
NewHaven	Dummy variable for New Haven borrower
NH*DTI	NewHaven * DTI
NH*AIAN	NewHaven * AIAN
NH*Asian	NewHaven * Asian
NH*Black	NewHaven * Black
NH*Hispanic	NewHaven * Hispanic
NH*Other	NewHaven * Other
NH*Local	NewHaven * Local
NH*LocDTI	NewHaven* Local * DTI
NH*LocAIAN	NewHaven * Local * AIAN
NH*LocAsian	NewHaven* Local * Asian
NH*LocBlack	NewHaven * Local * Black
NH*LocHispanic	NewHaven* Local * Hispanic
NH*LocOther	NewHaven * Local * Other
Years	Dummy variables for 2007, 2008, 2009, 2010, 2011, 2012, 2013
Tracts	Dummy variables for all tracts in Durham or New Haven

Variables	year ≤ 2010	year > 2010	all years
DTI	-0.055	0.199	-0.046
	(0.044)	(0.254)	(0.043)
AIAN	0.524	-3.249	0.474
	(0.475)	(1283.008)	(0.461)
Asian	-0.314	-3.461	-0.379
	(0.379)	(425.629)	(0.374)
Pacific	-3.700	-3.063	-3.708
	(234.858)	(2020.929)	(240.579)
Black	0.555	-3.525	0.569
	(0.097)***	(277.594)	(0.093)***
Hispanic	0.398	-3.732	0.392
	(0.182)**	(581.791)	(0.178)**
Other	0.217	0.503	0.237
	(0.149)^	(0.546)	(0.142)*
Local	0.198	1.603	0.467
	(0.135)^	(0.854)*	(0.128)***
LocDTI	0.064	-0.325	0.050
	(0.045)^	(0.255)^	(0.043)
LocAIAN	-0.156	3.751	-0.031
	(0.607)	(1283.008)	(0.518)
LocAsian	0.249	3.314	0.245
	(0.411)	(425.629)	(0.388)
LocPacific	-0.615	3.839	3.936
	(306.107)	(2020.929)	(240.580)
LocBlack	-0.048	3.975	-0.159
	(0.111)	(277.594)	(0.100)
LocHispanic	0.425	4.436	0.337
	(0.201)**	(581.791)	(0.186)*
LocOther	-0.023	-0.805	-0.290
	(0.169)	(0.557)^	(0.154)*

TABLE 11. Local lender model with NH interaction

Significance: ^ 20%   *10%   **5%   ***1%

Controlled for year and tract fixed effects

Variables	year ≤ 2010	year > 2010	all years
NewHaven	-0.237	1.474	-0.129
	(0.294)	(0.992)^	(0.424)
NH*DTI	0.117	-0.164	0.104
	(0.052)**	(0.277)	(0.050)**
NH*AIAN	-4.924	-	-0.276
	(205.232)	-	(0.594)
NH*Asian	-0.026	-0.865	-0.003
	(0.415)	(664.686)	(0.409)
NH*Pacific	-0.208	-0.870	-0.252
	(294.796)	(0.560)^	(305.893)
NH*Black	-0.336	4.278	-0.309
	(0.128)***	(277.594)	(0.122)***
NH*Hispanic	-0.372	4.088	-0.337
	(0.202)*	(581.791)	(0.196)*
NH*Other	-0.288	-0.475	-0.279
	(0.174)*	(0.620)	(0.165)*
NH*Local	0.255	-1.991	-0.172
	(0.165)^	(0.914)**	(0.154)
NH*LocDTI	-0.158	0.276	-0.121
	(0.054)***	(0.279)	(0.052)**
NH*LocAIAN	5.157	-	0.042
	(205.233)	-	(0.682)
NH*LocAsian	-0.036	0.631	-0.077
	(0.457)	(664.686)	(0.431)
NH*LocPacific	4.912	-	0.234
	(354.187)	-	(305.893)
NH*LocBlack	0.255	-4.448	0.273
	(0.145)*	(277.594)	(0.132)**
NH*LocHispanic	-0.075	-4.488	-0.051
	(0.223)	(581.791)	(0.206)
NH*LocOther	0.448	0.969	0.624
	(0.198)**	(0.633)^	(0.181)***
Constant	-1.597	-2.616	-1.323
	(0.194)***	(0.891)***	(0.289)***
Pseudo R2	0.163	0.115	0.135

Significance: ^ 20%   *10%   **5%   ***1%

Controlled for year and tract fixed effects

VI. Conclusion

The goal of this study was to examine the effect of minority history on racial disparities in the mortgage market and test the effect of the mortgage market reforms on lending patterns. Durham and New Haven were chosen as the subjects of this case study due to their contrasting racial dynamics and urban history of minority integration.

From an examination of U.S. Census statistics and residential segregation measures, it was found that Durham has a larger geographic separation among its race groups than New Haven. While Blacks were the dominant and most long-established minority race in Durham, New Haven had a larger Hispanic community and better integration among all races. It was also discovered that Durhamites have a higher level of income than New Haven residents. However, Durham showed a wider wealth disparity among the different races, with Hispanics having more income than Blacks on average. Income levels in New Haven were more comparable among all races.

Given this qualitative backdrop, tobit and probit regressions were employed to analyze mortgage rate spreads and subprime probability in the two cities. Indicator variables for local lenders were incorporated to reflect the local lending culture on racial perception. The national lender variables reflected the general risk measures not subject to local culture, including spillover effects and objective credit risk measures.

As mentioned in the introduction, the first hypothesis of this paper was that the Black variable will be less positively correlated with subprime rates for Durham than New Haven due to Durham's African American heritage. At the local level in the tobit and pre-2010 probit models, this was proven to be true. Local lenders in Durham treated Blacks better than Hispanics, while the contrary was true for lenders in New Haven where Hispanics had better-established communities. At the national level, however, Durham minorities, especially

Blacks, were charged with higher mortgage rates in response to greater spillover risk.

The second hypothesis of this paper was that the 2010 mortgage reforms diminished the degree of racial disparity in the mortgage markets. The temporal variation probit results were robust and produced expected results. The significance of race variables disappeared for the years after 2010, proving that the reform was successful in excluding race as a determinant of borrower risk. However, the DTI ratio, which was this study's proxy for credit risk, showed inconsistent and insignificant results. In future studies, it may be valuable to control other credit risk measures like the borrower's level of education and non-mortgage indebtedness to find results that are more consistent with the expected effects of the mortgage reform.

The final hypothesis of this paper was that regional complexities arising from racial dynamics could outweigh conventional credit risk factors in determining lending decisions. This hypothesis was proven to be true in the form of racial bias and spillover risk. In the pre-2010 probit and Local Lender tobit regressions, race perception was a significant predictor of higher subprime rates. Furthermore, local lenders showed clearly favorable attitudes towards the dominant minority group of their city. Despite the fact that they are wealthier than Blacks, Hispanics in Durham were still charged much higher mortgage rates than African Americans. In the post-2010 probit, the racial bias factor disappeared but the racial spillover effect persisted. National lenders consistently charged higher spreads to Durham minorities than New Haven due to their greater degree of racial homogeneity in many neighborhoods.

In conclusion, the socioeconomic dynamics resulting from racial legacy were observed to have notable implications in the mortgage market. In the empirical regressions, racial bias and geographic segregation clearly outweighed traditional credit risk measures in influencing lending decisions. The local lender

variable was instrumental in highlighting the effect of race perception, and showed that Durham clearly favored Blacks over Hispanics while New Haven treated Hispanics as favorably as Blacks. On the other hand, national lenders regarded Durham Blacks as more risky due to their high degree of residential homogeneity. This study hence found that African American legacy can foster positive race perception towards Blacks, but also exacerbate the risks resulting from racial segregation.

Data Sources

Consumer Financial Protection Bureau. (2014). Home Mortgage Disclosure Act
    Custom Datasets. Retrieved October 30, 2014, from
    http://www.consumerfinance.gov/hmda/explore.
U.S. Census Bureau. (2014). State & county Quickfacts: Durham, N.C. Retrieved
    October 5, 2014, from http://quickfacts.census.gov.
U.S. Census Bureau. (2014). State & county Quickfacts: New Haven, C.T.
    Retrieved October 5, 2014, from http://quickfacts.census.gov.
Home Mortgage Disclosure Act. (2014). Aggregate Reports: Durham, N.C.
    Retrieved October 5, 2014, from
    http://www.ffiec.gov/HmdaAdWebReport/AggWelcome.aspx.
Home Mortgage Disclosure Act. (2014). Aggregate Reports: New Haven, C.T.
    Retrieved October 5, 2014, from
    http://www.ffiec.gov/HmdaAdWebReport/AggWelcome.aspx.
Index of Dissimilarity (Segregation Index) for Durham and New Haven. Racial
    Residential Segregation Census 2000 Findings. Retrieved March 17, 2015,
    from http://enceladus.isr.umich.edu/race/racestart.asp.
List of National Banks & Federal Branches and Agencies active as of 1/31/2015.
    Office of the Comptroller of the Currency. Retrieved February 1, 2015,
    from http://www.occ.gov/topics/licensing/national-bank-lists/index-active-
    bank-lists.html.
Silady, Alex. The Top Ten Mortgage Lenders in 2014. Mortgage. Retrieved
    February 1, 2015, from https://smartasset.com/mortgage/the-top-ten-
    mortgage-lenders-in-2014.
Segregation: Dissimilarity Indices. Retrieved Febraury March 17, 2015m from
    http://www.censusscope.org/segregation.html.

References

African-american heritage. 2014 [cited 10/03 2014]. Available from
    http://www.durham-nc.com/visitors/durham-Black-history/durhams-
    Black-heritage-story.html.
Durham's Black wall street. 2014 [cited 10/03 2014]. Available from
    http://www.learnnc.org/lp/editions/nchist-newcentury/6001.
Ashton, Philip. 2012. 'Troubled assets': The financial emergency and racialized
    risk. International Journal of Urban and Regional Research 36 (4): 773-90.
Avery, Robert B., Kenneth P. Brevoort, and Glenn B. Canner. 2007.
    Opportunities and issues in using HMDA data. The Journal of Real Estate
    Research 29 (4) (Oct-Dec 2007): 351-79,

http://search.proquest.com.proxy.lib.duke.edu/docview/200316610?accountid=10598.

Avery, Robert B., Kenneth P. Brevoort, and Glenn B. Canner. 2006. Higher-priced home lending and the 2005 HMDA data. Federal Reserve Bulletin 92 : A123-66, http://search.proquest.com.proxy.lib.duke.edu/docview/219505538?accountid=10598.

Bhardwaj, Geetesh, and Rajdeep Sengupta. 2012. Subprime mortgage design. Journal of Banking & Finance 36 (5) (5): 1503-19.

Bhutta, Neil. 2012. GSE activity and mortgage supply in lower-income and minority neighborhoods: The effect of the affordable housing goals. Journal of Real Estate Finance and Economics 45 (1) (Jun 2012): 238-61, http://search.proquest.com.proxy.lib.duke.edu/docview/1021003849?accountid=10598.

Bobo, Lawrence, and Camille L. Zubrinsky. 1996. Attitudes on residential integration: Perceived status differences, mere in-group preference, or racial prejudice? Social Forces 74 (3) (Mar.): 883-909, http://www.jstor.org/stable/2580385.

Bradley, Jeanette, and Skillern, Peter. Predatory lending. 2000 [cited 9/9 2014]. Available from http://nhi.org/online/issues/109/bradley.html.

Brueckner, Jan K., Paul S. Calem, and Leonard I. Nakamura. 2012. Subprime mortgages and the housing bubble. Journal of Urban Economics 71 (2): 230-43.

Brueckner, Jan K., Paul S. Calem, and Leonard I. Nakamura. 2012. Subprime mortgages and the housing bubble. Journal of Urban Economics 71 (2) (3): 230-43.

Calem, Paul S., Kevin Gillen, and Susan Wachter. 2004. The neighborhood distribution of subprime mortgage lending. Journal of Real Estate Finance and Economics 29 (4) (Dec 2004): 393-410, http://search.proquest.com.proxy.lib.duke.edu/docview/203162018?accountid=10598.

Canner, Glenn B., Stuart A. Gabriel, and J. Michael Woolley. 1991. Race, default risk and mortgage lending: A study of the FHA and conventional loan markets. Southern Economic Journal 58 (1) (Jul.): 249-62, http://www.jstor.org/stable/1060046.

Canner, Glenn B., and Wayne Passmore. 1999. The role of specialized lenders in extending mortgages to lower-income and minority homebuyers. Federal Reserve Bulletin 85 (11) (Nov 1999): 709-23, http://search.proquest.com.proxy.lib.duke.edu/docview/219512123?accountid=10598.

Cumings, Bruce, 1943-. 2010. The korean war : A history. New York: Modern
    Library, http://search.library.duke.edu/search?id=DUKE004346159.

Danis, Michelle A., and Anthony Pennington-Cross. 2008. The delinquency of
    subprime mortgages. Journal of Economics and Business 60 (1–2) (0): 67-
    90.

DeLoughy, Sara T. 2012. Risk versus Demographics in subprime mortgage
    lending. The Journal of Real Estate Finance and Economics 45 (3): 569-
    87.

Demyanyk, Yuliya, and Otto Van Hemert. 2011. Understanding the subprime
    mortgage crisis. The Review of Financial Studies 24 (6): 1848-80.

Dickerson, Mechele A. 2006. Race matters in bankruptcy reform. Missouri Law
    Review 71 (4): 919.

Digital NC. Durham urban renewal records. 2014 [cited 10/03 2014]. Available
    from http://www.digitalnc.org/exhibits/durham/.

Dymski, Gary. 2001. Is discrimination disappearing? racial differentials in access
    to credit, 1992-1998. International Journal of Social Economics 28 (10):
    1025.

Dymski, Gary A. 2009. Racial exclusion and the political economy of the
    subprime crisis. Historical Materialism 17 (2): 149-79,
    http://search.proquest.com/docview/61747477?accountid=10598.

Dymski, Gary, Jesus Hernandez, and Lisa Mohanty. 2013. Race, gender, power,
    and the US subprime mortgage and foreclosure crisis: A meso analysis.
    Feminist Economics 19 (3) (Jul 2013): 124-51,
    http://search.proquest.com.proxy.lib.duke.edu/docview/1504422033?acco
    untid=10598.

Flippen, Chenoa A., and Emilio A. Parrado. 2012. Forging hispanic communities
    in new destinations: A case study of durham, north carolina. City &
    Community 11 (1): 1-30.

Freidman, Samantha. 2008. Do declines in residential segregation mean stable
    neighborhood racial integration in metropolitan america? A research note.
    Social Science Research 37 (3) (9): 920-33.

Haughwout, Andrew, Christopher Mayer, Joseph Tracy, Dwight M. Jaffee, and
    Tomasz Piskorski. 2009. Subprime mortgage pricing: The impact of race,
    ethnicity, and gender on the cost of borrowing. Brookings-Wharton Papers
    on Urban Affairs: 33-63, http://www.jstor.org/stable/25609559.

Heckman, James J. 1979. Sample selection bias as a specification error.
    Econometrica 47 (1) (Jan.): 153-61, http://www.jstor.org/stable/1912352.

Hoffman, Karen Epper. 2014. Mortgage regulations, ready or not? Independent
    Banker 64 (1) (Jan 2014): 42-5,
    http://search.proquest.com.proxy.lib.duke.edu/docview/1525442240?acco
    untid=10598.

Huszár, Zsuzsa R., George H. Lentz, and Wei Yu. 2012. Does mandatory disclosure affect subprime lending to minority neighborhoods? Journal of Economics and Finance 36 (4) (Oct 2012): 900-24, http://search.proquest.com.proxy.lib.duke.edu/docview/1465502666?accountid=10598.

Iceland, John, Daniel H. Weinberg, and Erika Steinmetz. 2002. Racial and ethnic residential segregation in the united states: 1980-2000. U.S. Census Bureau.

Iceland, John. 2004. Beyond Black and White: Metropolitan residential segregation in multi-ethnic america. Social Science Research 33 (2) (6): 248-71.

Immergluck, Daniel. 2004. Credit to the community : Community reinvestment and fair lending policy in the united states. Armonk, N.Y.: M.E. Sharpe, http://search.library.duke.edu/search?id=DUKE003361561.

Kau, James B., Donald C. Keenan, Constantine Lyubimov, and V. Carlos Slawson. 2011. Subprime mortgage default. Journal of Urban Economics 70 (2–3) (0): 75-87.

Krysan, Maria. 2008. Does race matter in the search for housing? an exploratory study of search strategies, experiences, and locations. Social Science Research 37 (2) (6): 581-603.

Kwolek-Folland, Angel. 1994. Black business in the new south: A social history of the north carolina mutual life insurance company. Business History Review 68 (2) (Summer 1994): 287, http://search.proquest.com/docview/274393576?accountid=10598.

McKinley, Shepherd W., and McKinley, Cynthia R. The great migration and north carolina. 2006 [cited 10/03 2014]. Available from http://www.learnnc.org/lp/editions/nchist-newcentury/5996.

Morial, Marc H. 2008. Minorities not to blame for subprime mess. Sacramento Observer, Oct 23-Oct 29, 2008, 2008. http://search.proquest.com.proxy.lib.duke.edu/docview/367506717?accountid=10598.

Munnell, Alicia H., Geoffrey M. B. Tootell, Lynn E. Browne, and James McEneaney. 1996. Mortgage lending in boston: Interpreting HMDA data. The American Economic Review 86 (1) (Mar.): 25-53, http://www.jstor.org/stable/2118254.

Peicuti, Cristina. 2013. Securitization and the subprime mortgage crisis. Journal of Post Keynesian Economics 35 (3) (Spring): 443-55, http://search.ebscohost.com/login.aspx?direct=true&db=eoh&AN=1382304&site=ehost-live&scope=site; http://mesharpe.metapress.com/openurl.asp?genre=journal&issn=0160-3477.

Pennington-Cross, Anthony, and Joseph Nichols. 2000. Credit history and the
    FHA?conventional choice. Real Estate Economics 28 (2): 307-36.
Philips, Sandra. 2012. The subprime mortgage calamity and the african american
    woman. The Review of Black Political Economy 39 (2): 227-37.
Quinn, Lois M., and John Pawasarat. 2002.
Racial integration in urban america: A block level analysis of african american
    and White housing patterns Employment and Training Institute,
    University of Wisconsin-Milwaukee.
Repass, Jerre. 2006. Black wall street durham, north carolina. About ... Time.,
    http://search.proquest.com/docview/197960628?accountid=10598.
Review of Banking and Financial Law. 2010. Anti-predatory lending: Title XIV
    of the dodd-frank act. Developments in Banking and Financial Law 30 (1):
    93-101.
Scheessele, Randall M. 2002. Black and White disparities in subprime mortgage
    refinance lending. Housing Finance Working Paper Series HF-014 .
Schwartz, Herman M. 2009. Subprime mation : American power, global capital,
    and the housing bubble. Ithaca: Cornell University Press,
    http://search.library.duke.edu/search?id=DUKE004224464.
Shiller, Robert J. 2014. Why is housing finance still stuck in such a primitive
    stage? American Economic Review 104 (5): 73-6.
Smith, Marvin M., and Christy Chung Hevener. 2014. Subprime lending over
    time: The role of race. Journal of Economics and Finance 38 (2): 321-44.
Sutherland, Jean. Examining the african american role in new haven history: Pride
    in the past, hope for the future. 1992 [cited 10/03 2014]. Available from
    http://yale.edu/ynhti/curriculum/units/1992/3/92.03.08.x.html.
United States Department of Housing and Urban Development. 2000. Curbing
    predatory home mortgage lending : A joint report, ed. United States.
    Department of the Treasury. Washington, D.C.]: U.S. Dept. of Housing
    and Urban Development : U.S. Dept. of Treasury,
    http://search.library.duke.edu/search?id=DUKE002784882.
Wonderly, Joe. 2011. Anti-predatory lending: Title XIV of the dodd-frank act.
    Review of Banking & Financial Law 30 : 93.
Wyly, Elvin K., and Steven R. Holloway. 2002. The disappearance of race in
    mortgage lending. Economic Geography 78 (2) (Apr.): 129-69,
    http://www.jstor.org/stable/4140785.
Zonta, Michela M. 2012. Applying for home mortgages in immigrant
    communities: The case of asian applicants in los angeles. Environment
    and Planning A 44 (1): 89-110.

Appendix 1 List of national mortgage lenders

Top 95 national mortgage lenders (with deposit sizes greater than $1 billion)					
HMDA Code	Charter No	HMDA Name	HMDA Code	Charter No	HMDA Name
13-4994650	8	JPMORGAN CHASE BANK, NA	16-0538020	501105	M&T BANK
57-0236115	13044	BANK OF AMERICA, N.A.	34-0797057	14761	KEYBANK NATIONAL ASSOCIATION
94-1347393	1741	WELLS FARGO BANK, NA	75-0187990	23834	CITIZENS BANK NA
13-5266470	1461	CITIBANK, N.A.	13-3571598	2182786	GOLDMAN SACHS BANK USA
31-0841368	24	US BANK, N.A.	63-0476286	697633	COMPASS BANK
38-2603955	7197000003	QUICKEN LOANS	38-0477375	60143	COMERICA BANK
20-2031771	2317700005	PHH HOME LOANS	74-2291652	7975	USAA FEDERAL SAVINGS BANK
26-2049351	26-2049351	PENNYMAC LOAN SERVICES LLC	20-1001796	57803	ALLY BANK
38-2734984	8412	FLAGSTAR BANK	23-1237295	4410	SANTANDER BANK N.A.
75-2921540	75-2921540	NATIONSTAR MORTGAGE LLC	31-0966785	7745	THE HUNTINGTON NATIONAL BANK
13-5160382	541101	THE BANK OF NEW YORK MELLON	94-0475440	3514	BANK OF THE WEST
22-1146430	1316	PNC BANK N.A.	45-3449011	4421069	DISCOVER HOME LOANS, INC.
72-0210640	13688	CAPITAL ONE NA	13-4941247	214807	DEUTSCHE BANK TRUST COMPANY AM
504713	24	US BANK, N.A.	87-0477597	3212149	UBS BANK, USA
01-0137770	24096	TD BANK N.A.	72-0210640	13688	CAPITAL ONE NA
58-0466330	675332	SUNTRUST BANK, INC	80-0513856	4114567	FIRST REPUBLIC BANK
56-1074313	9846	BRANCH BANKING AND TRUST CO	13-3090509	80028	BANK OF CHINA
20-1177241	24522	HSBC BANK USA, NA	94-2875288	802866	SILICON VALLEY BANK
22-3458456	36-2677063	MORGAN STANLEY PRIVATE BANK NA	95-1780067	14695	CITY NATIONAL BANK
31-1197926	2712969	FIFTH THIRD MORTGAGE COMPANY	16-0428985	17945	FIRST NIAGARA BANK
42-1558009	18077	CHARLES SCHWAB BANK	23-3097422	57282	CITIZENS BANK OF PENNSYLVANIA
63-0371391	233031	REGIONS BANK	27-2371197	27-2371197	NYCB MORTGAGE COMPANY LLC
36-1561860	210434	THE NORTHERN TRUST CO.	06-1213065	18027	PEOPLE'S UNITED BANK
36-2085229	14583	BMO HARRIS BANK N.A.	95-2795851	197478	EAST WEST BANK

HMDA Code	Charter No	HMDA Name	HMDA Code	Charter No	HMDA Name
74-0635455	5179	FROST BANK	47-0259043	209	FIRST NATIONAL BANK OF OMAHA
13-4149421	57053	SIGNATURE BANK	26-4382801	3918898	ONEWEST BANK, FSB
63-1113916	63-1113916	SYNOVUS MORTGAGE CORPORATION	25-0659306	6301	BNY MELLON, N.A.
22-3458456	2489805	MORGAN STANLEY PRIVATE BANK NA	23-0570293	682611	SUSQUEHANNA BANK
66-0561870	940311	BANCO POPULAR DE PUERTO RICO	36-3722148	33306	THE PRIVATEBANK AND TRUST CO.
73-0780382	13679	BOKF NA	27-0217289	3938186	BANKUNITED
22-1002380	17969	HUDSON CITY SAVINGS BANK	44-0194180	23920	UMB BANK NA
34-1812174	34-1812174	FIRSTMERIT MORTGAGE CORP	38-0437390	1597	FIRSTBANK
41-0274830	10212	COMMERCE BANK	22-1368780	28892	INVESTORS BANK
56-0223230	11063	FIRST-CITIZENS BANK & TRUST CO	71-0118700	311845	ARVEST BANK
39-1941673	23695	ASSOCIATED BANK NA	99-0033900	795968	BANK OF HAWAII
90-0394403	3688052	SCOTTRADE BANK	72-0218470	808176	IBERIABANK
59-2324433	24963	PROSPERITY BANK	73-1139790	17174	VALLEY NATIONAL BANK
93-0419143	17266	UMPQUA BANK	95-3671242	24045	PACIFIC WESTERN BANK
62-0201385	336	FIRST TENNESSEE BANK NA	75-2695994	23248	TEXAS CAPITAL BANK
06-1187536	24469	WEBSTER BANK, N.A.	25-1255405	249	FIRST NATIONAL BANK OF PA
72-1171087	33029	WHITNEY BANK	95-3463626	24583	RABOBANK, N.A.
87-0189025	4341	ZIONS FIRST NATIONAL BANK	36-1474915	13684	MB FINANCIAL BANK NA
41-0585310	23253	TCF NATIONAL BANK	76-0028668	17479	AMEGY BANK OF TEXAS, NA
01-0137770	24096	TD BANK N.A.	91-0135860	880	WASHINGTON FEDERAL
51-0407970	2980209	BARCLAYS BANK DELAWARE	64-0117230	11813	BANCORPSOUTH BANK
99-0034327	17985	FIRST HAWAIIAN BANK	37-1381494	14640	STATE FARM BANK
59-3531592	15115	EVERBANK	13-0822710	16068	APPLE BANK FOR SAVINGS
			59-3244348	12002	RAYMOND JAMES BANK, NA

Appendix 2   Calculation of segregation indices
by the University of Michigan Population Studies Center

Appendix 2.1 Dissimilarity Index
This index measures the evenness with which two mutually exclusive groups are distributed across the geographic units that make up a larger geographic entity; for example, the distribution of Blacks and Whites across the census tracts that make up a city. Its minimum value is zero and its maximum value is 100. Suppose:

b_i = the black population of the ith areal unit, e.g. census tract
B = the total black population of the large geographic entity for which the Dissimilarity Index is being calculated.
w_i = the white population of the ith area unit, e. g. census tract
W = the total white population of the large geographic entity for which the Dissimilarity Index is being calculated

Then the Dissimilarity Index measuring the segregation of whites from blacks is:
$$(1/2) \text{ SUM } (b_i / B - w_i / W)$$
The summation is over the component areal units such as census tracts.

Appendix 2.2 Exposure Index
Assume:

w_i = the white population of a component part, e. g. census tract, of the larger
geographic entity for which the Exposure Index is being calculated.
b_i = the black population of a component part of the larger geographic entity for white
the Exposure Index is being calculated.
t_i = the total population of a component part of the larger geographic entity for which the Exposure Index is being calculated.
W = the total white population of the larger geographic entity for which the Exposure Index is being calculated.

Then the average percent black in the geographic unit of the typical or average white will be calculated as:
$$\text{SUM } ((w_i / W) * (b_i / t_i))$$
The summation is over all the geographic units, e. g. census tracts, comprising the larger geographic entity for which the Exposure Index is being calculated.