12-2016

Evaluating Home Lending Patterns for Discrimination in Worcester, MA

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Abstract: This paper analyzes home lending trends measured in dollars lent per census tract per capita in Worcester, MA, in order to determine whether anti-discrimination measures have been successful, and to suggest this framework for analysis and policy remedies for cities with similar challenges. When analyzed alone with Federal Housing Administration (FHA) and conventional lending by tract, proportional rates of African-American residency were found to be negatively correlated with conventional lending, and Hispanic residency was found to be negatively correlated with both conventional and FHA lending, rejecting the null hypothesis that race/ethnicity and home lending would have no observable relationship. When compared in multi-variate analysis alongside other neighborhood characteristics that could influence mortgage lending, however, rates of owner-occupancy, foreclosures, and median income were discovered to be strongly correlated with home lending trends, while race/ethnicity was not. Given these findings, there is insufficient evidence to conclude the active presence of discriminatory lending, but the sum of these analyses demonstrates a statistically significant link between low to median income, low homeownership, and Hispanic and African-American population in the city of Worcester.

Academic History: Curtis Wiemann, B.A. History, Clark University 2012, M.A. History, Clark University 2013

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Introduction

Since its signature into law in 1977, the Community Reinvestment Act (CRA) has represented a vital cornerstone of financial regulation in service of community redevelopment. Intended to curb the discriminatory lending practices ("red-lining") of banks and other brick-and-mortar financial institutions, the CRA and the related program of home loans under the Federal Housing Administration aims to offer the keystone of American equity growth – homeownership – to families and communities otherwise subject to systemic disinvestment. After nearly forty years of regulatory practice amidst a changing financial and political landscape, it is the goal of this paper to assess the impact of the CRA and the FHA in ending geographic patterns of discrimination in home lending, and by doing such erode or efface the geographic link between racial and ethnic minority populations and poverty embodied in American cities' slums, tenements, and "ghettos" throughout the nation's history. This evaluation, it is hoped, will help to inform anti-discrimination policy implementation and evaluation at the municipal level in the subject city and other municipalities working to increase homeownership and undo the geographic impacts of systemic discrimination.

The methodology of this paper is to evaluate the success of anti-discrimination lending laws in Worcester, Massachusetts by comparing rates of mortgage lending in 2015 with rates of minority population by census tract and analyzing this observed relationship in comparison with neighborhood characteristics that might indicate barriers to mortgage investment (such as low median income and low rates of owner-occupancy).

Worcester, Massachusetts, was chosen as the geographic subject of the project for several reasons. First, Worcester is presently described amongst other New England industrial metropolises as a weak market city, with limited housing demand and no market for middle-to-high end housing development as compared to the large and aging quantity of housing stock, both of which depress market prices.[1] It also is a city of demographic diversity, including older white and African American populations as well as new immigrants from Latin America, Asia, Europe and Africa. These characteristics make pressing the issues of housing investment distribution and discrimination. Although Worcester's rate of homeownership stands under national averages at 46.6%, the city has far higher rates of owner-occupancy than neighboring metropolises such as Springfield, Hartford, or Providence.[2] The framework of federal housing legislation studied in this paper exists to support the growth of homeownership in cities such as Worcester, where the free market has struggled to sustain housing prices at a level that incentivizes new construction, and the population contains significant numbers of minority residents who could be disserved by discriminatory red-lining. In addition to the factors above, the data collection undertaken for the set of regression analyses was complemented by windshield surveys of Worcester's neighborhoods.

This multi-variate regression analysis is undertaken with the null hypothesis that there is no relationship between a neighborhood's racial composition and its respective rate

[1] Peter Cohen,"Why are Worcester's Housing Prices Stuck?" *Worcester Telegram and Gazette*, June 11, 2014, http://www.telegram.com/article/20140611/COLUMN70/306119997.

[2] -, "Worcester by the Numbers: Housing and Land Use." *Worcester Regional Research Bureau, Inc*, 13:7 (Aug. 2013), http://www.wrrb.org/wp-content/uploads/2014/07/worcester-by-the-numbers-housing-and-land-report-2013.pdf.

of mortgage lending. In order to correct against rates of minority population masking other salient variables that bear upon mortgage lending rates, the minority populations of each census tract will be compared against median incomes, rates of foreclosures, and rates of owner-occupancy by census tract.

It is the hypothesis of this paper that Hispanic and African-American populations in the city of Worcester have a measurable relationship when analyzed alone with rates of mortgage lending in 2015, and that this relationship will be negative. First, it is expected that mortgage lending trends will reflect bias against African-American or Hispanic borrowers in the form of lower rates of mortgage origination. Many of the precedents for this paper's analysis (outlined in the Literature Review chapter) lend credence to the continued existence and monetary influence of racial discrimination in mortgage lending. In Boston and New York, as well as other examples across the United States, comparable regression analyses have uncovered evidence of a statistically-significant negative relationship between minority populations and mortgage lending trends.

In addition to outright discrimination, it is the contention of this paper that the negative relationship between mortgage lending and minority populations in Worcester is complicated by the phenomenon of segregation and the resultant concentration of minority populations in neighborhoods deemed high-risk by mortgage lenders. This particular manifestation of segregation is fundamental to the practice of red-lining, combining simple bias against African-American or Hispanic borrowers with geographic indicators of risk. A very oversimplified history of race in the modern United States depicts a chain of cause

and effect from bias to segregation upheld by economic sanction, whereby African-American workers move to urban centers for employment, were shut out from opportunities for economic success (job promotion, job access, or home lending, as examples), settled in urban neighborhoods within their economic ability, and saw increasing disinvestment in these neighborhoods under programs like urban renewal in the 1960's or formal boundaries against departure erected in the metrics of the historic Home Owners' Loan Corporation (HOLC). Although the programmatic approach of urban renewal has been improved by public process and the HOLC has been dissolved, their impacts remain a crucial force behind the ongoing existence of segregation in American society. This paper identified that census tracts with low median incomes and low rates of homeowner occupancy also have disproportionately high rates of minority populations in the city of Worcester, and that these non-racial characteristics are relevant as negative incentives for mortgage lending even in the absence of explicit racial bias on the part of home mortgage lenders.

Census data suggests that unlike many larger cities with enclaves of immigrant or minority populations, Worcester's African-American and Hispanic population is dispersed across all 44 census tracts, making housing bias harder to perpetrate and evaluate on a geographic level. Further, Home Mortgage Disclosure Act (HMDA) data suggests that there are relatively low numbers of mortgages initiated citywide. Despite characteristics of high homeownership discussed in the Methodology section below, most housing turnover in the city of Worcester at present appears to be rental units rather than mortgaged homes.

These characteristics of low home purchase rates and dispersed minority population pose potential challenges to a robust model of housing discrimination.

The findings of this paper demonstrate a correlation between rates of minority populations and mortgage lending in the city of Worcester, but that this correlation is less significant as a predictor of mortgage lending trends by census tract than foreclosure rates, median income, and rates of owner-occupancy. This mixed result suggests that current anti-discrimination measures have been effective in curbing explicit racial bias against borrowers and neighborhoods, but that race and geographic poverty continue to share a statistically significant relationship that leads in effect to lower home lending to predominantly minority neighborhoods. The policy implications of this paper would include the maintenance of current anti-discrimination measures including the CRA and FHA lending, but also suggest the need for buttressing these programs with municipal policy aimed at helping minority borrowers and neighborhoods to achieve higher incomes and avenues for homeownership. Worcester's community development corporations (CDCs) and community development financial institutions (CDFIs) already play a significant role in developing low income housing and accepting risk in developing in underserved neighborhoods. The limited correlation between race and lending trends as compared to the strength of median income, foreclosure rates, and owner-occupancy as relevant variables for mortgage lending can help to model further avenues of community development in Worcester aimed at these neighborhood characteristics to allow for growth in homeownership without lending discrimination.

Review of Literature

This study relies on a number of secondary sources and case studies as the basis for its theoretical direction and methodology. Several authors in Massachusetts and beyond have relied upon similar statistical analysis to determine the impacts of anti-discrimination legislation. The approach and choice of variables, however, have differed dramatically, influenced by the varying agendas and disciplines of analysis. Despite the similar methodological approaches and data sources shared by many of these studies, the above-mentioned reports and countless others reflect a lack of consensus upon the mechanisms, impact, or even existence of discriminatory red-lining. In the body of literature regarding evaluation of the CRA and anti-discrimination impacts, there is a marked contrast between regulators and academics on the one hand and economists in the banking sector on the other. Academics and regulators focus upon observable impacts in community demographics, and frequently argue for a stronger mandate for the CRA and other anti-discrimination programs given the ongoing geographic concentration of minority populations in poverty. Bank officials and economists focus upon the effect of regulation on the lending market and conclude frequently that no further oversight is needed and that existing geospatial variance in lending trends conform to rational market forces rather than discrimination. The sources outlined below include both perspectives and several analyses that use a similar regression analysis approach to study the subject of discrimination in home lending.

Neil Bhutta's “The Community Reinvestment Act and Mortgage Lending to Lower

Income Borrowers and Neighborhoods," closely mirrors the intended goals of this paper, providing a larger national analysis of CRA efficacy using many of the same data sources upon which this project will rely.[3] Bhutta argues that CRA lending overall had little impact on low-income lending, but had positive effects in reducing externalities rooted in racial bias and lack of information in large metropolitan areas in the late 1990's and early 2000's, where regulation was enforced more strictly. In these cases, the CRA was successful in driving bank lending to low-income tracts, thus generating information regarding risk derived from foreclosure rates and a growing body of bank loans. This, in turn, eliminated a market externality rooted in a lack of information and served to increase loans from both CRA-compliant institutions as well as non-CRA lenders who became involved following their example. Overall, the market moved towards greater lending for low-income homebuyers, but the CRA was found to have muted effect outside of the virtuous cycle described above.

"The Community Reinvestment Act and Targeted Mortgage Lending," by Drew Dahl, Doughlass Evanoff, and Michael Spivey. looks at the overall impacts and goals of the CRA's mortgage lending oversight, complementing the Bhutta article above in terms of looking at the larger impact illustrated by the data gathered from lending trends.[4] These authors specifically look at banking activity in periods of rating change (an immediate period in which CRA-compliant banks were subject to re-valuation by auditors and

[3] Neil Bhutta, "The Community Reinvestment Act and Mortgage Lending to Lower Income Borrowers and Neighborhoods." *The Journal of Law and Economics*, 54:4. (Nov., 2011). pp. 953-983.
[4] Drew Dahl, Douglass Evanoff, and Michael Spivey, "The Community Reinvestment Act and Targeted Mortgage Lending." *Journey of Money, Credit, and Banking*, 42: 7 (Oct. 2010), pp. 1351-1372.

therefore were under great pressure to maintain compliance) and determined that past reforms were effective in increasing lending to low-to-moderate income borrowers, while downgrades in bank's ratings had less impact. The reforms found to have the greatest positive impact linked bank rating to community outcomes, including a broad range of activities undertaken by lending institutions beyond consciously adapted lending to appeal to regulatory oversight when such oversight was an immediate keystone of an impending merger. Punishing banks by downgrading their rating without an impending merger was shown to have limited effect on compliant lending, by contrast.

In addition to economic analysis, the perspective of legislative regulators provides formal analysis and success measures for the CRA in achieving its ultimate goal of combating discrimination and systemic oppression. "The Performance and Profitability of CRA-Related Lending," a Federal Bank report issued to Congress, underlines the issues and challenges faced by the CRA on its 25th anniversary in the year 2000.[5] Amongst their concerns, regulators noted the expanding scope and shape of the financial lending market, which threatened to make obsolete the lending requirements of the CRA. Worryingly, the study reveals that only 30% of home loans were subject to CRA oversight as of the year of publication. These limitations may hinder CRA efficacy and suggest policy course for the future. Sandra Braunstein's "The Community Reinvestment Act," an address before the Committee on Financial Services of the U.S. House of Representatives, provides a less detailed but more contemporary summary of CRA challenges, eight years after the above

[5] -, "The Performance and Profitability of CRA-Related Lending." *Federal Reserve System* (July 2000), https://www.federalreserve.gov/communitydev/files/cra_cratext.pdf.

report.[6] She provides helpful context and history for the CRA, but also highlights the same issues of breadth and obsolescence that threatened the act on its 25th anniversary and hinder its efforts today. In addition, she offers potential directions for the CRA's improvement to better serve low-income communities, including potential expansion to non-depository financial institutions or to cover digital lending from institutions with no physical presence in or near the neighborhoods in which they invest. Both of these, she cautions, have extensive risks associated with effective compliance, given the wide range of institutions from international banks to pawn shops and check cashing companies that could be affected by new legislation.

There exist ample precedents for this study that inform this project's approach to studying mortgage discrimination and the methodology of a regression analysis. The Boston Federal Reserve Bank (Boston FED) and Redevelopment Authority (BRA, now known as the Boston Planning and Development Agency) have been at the forefront of redlining studies ever since the housing crisis in the city from 1988-1991. Explored in Dreir's "Redlining Cities," in 1988 Boston faced a financial scandal in the early months of the Flynn administration, as the populist mayor tasked the Federal Reserve Bank of Boston and BRA to investigate claims of lending discrimination in the wake of the nationwide Community Reinvestment Act overhaul following the 1988 S&L bailout.[7] Initial reports obtained by the press suggested that white applicants were up to 40% more likely to see

[6] Sandra Braunstein, "The Community Reinvestment Act." Address before the Committee on Financial Services, U.S. House of Representatives, February 13, 2008.
[7] Peter Dreir, "Redlining Cities: How Banks Color Community Development." *Challenge*, 34:6 (Nov., 1991), pp. 15-23.

their applications approved as compared to their minority counterparts in the city. The public furor that followed convinced city officials of their need to investigate lending activities with an eye towards racial and geographic equity.

One influential 1992 study, undertaken by the Federal Reserve Bank of Boston, expanded upon traditional analysis of red-lining by identifying and testing variables underrepresented in previous analyses of mortgage discrimination. Munnell et. al., "Mortgage Lending In Boston," utilizes mortgage data made available under the Home Mortgage Disclosure Act to undertake regression analysis aimed at uncovering whether the racial characteristics of census tracts influenced rates of mortgage origination.[8] The authors set out to complete a regression analysis similar to reports by the Boston Fed, but attempt to account for risk factors which could influence geographic lending patterns irrespective of minority populations, including unemployment rates and rates of poverty by neighborhood. The authors contend that non-biased lenders could withhold loans to individuals with bad credit, or in neighborhoods with historically high rates of foreclosure, and these rational market-driven decisions could disproportionately affect people of color without proving any formal practice of red-lining or mortgage discrimination, but demonstrating instead that poverty and race were intertwined prior to mortgage investment. Further, Munnell et al point out that previous studies neglect other conditional factors, such as default costs associated with past foreclosures, variable loan characteristics, and some relevant credit-impacting personal information. With a host of methodological flaws

[8] Alicia Munnell, Geoffrey Tootell, Lynn E Browne, and James McEneaney. "Mortgage Lending in Boston: Interpreting HMDA Data." *The American Economic Review*, 86:1 (Mar., 1996), pp.25-53.

identified, the authors rely on additional surveying and rates of annual foreclosure by tract as data to help assess the explanatory value of risk versus racial composition in determining rates of mortgage origination, ultimately utilizing the same tools of regression analysis selected for the present study. In a landmark discovery, the authors concluded that African-American and Hispanic applicants in Boston census tracts with similar characteristics, credit risks, and geographic risk factors to white counterparts were significantly less likely to have their loan applications approved. This study shaped discussion of mortgage lending and red-lining in the Commonwealth and broader United States, provoking critical rebuttals and methodological refinements for other settings such as those below.

Following directly in the example of Munnell et al., Tootell's "Redlining in Boston," published in The Quarterly Journal of Economics in late 1996, sought to refine studies of home lending discrimination in Boston by analyzing its correlation with race and with perceptions of race concentration.[9] Given this history and the litany of contrasting studies that followed in the wake of the 1988 CRA revisions and Boston's housing crisis of the same year, Tootell's study aims to measure geographic lending rates versus individual applicant successes, in both accounting for the race of applicants or the geographic concentration of minority populations. Ultimately, the article concludes that there is insufficient statistical evidence to conclude that geographically-determined red-lining is taking place in Boston, but that bias remains against minority applicants in the city

[9] Tootell, Geoffrey M. B. "Redlining in Boston: Do Mortgage Lenders Discriminate Against Neighborhoods?" *The Quarterly Journal of Economics*, 111:4 (Nov., 1996). pp. 1049-1079.

individually as measured in individual application success rates. Unlike traditional red-lining, where whole neighborhoods suffered discrimination for the presence or perception of minority residency, Tootell's article suggests that individual minority applicants struggled to see mortgage origination as compared to white clients with similar qualifications, but that neighborhoods with minority populations did not suffer statistically-significant discrimination beyond that suffered by their minority residents.

A counterexample of limited correlation between mortgage lending rates and neighborhoods' racial composition can be seen in Holmes and Horvitz, "Race, Risk, and Demand," published in the *Journal of Finance* in 1994.[10] Relying on the same HMDA and US Census datasets, the authors attempt to further refine the regression analysis carried out by Munnell et al, arguing again that risk was insufficiently assessed in previous studies to their own, but also that assessments of differing levels of credit demand were absent from previous reports. Corrected for these variables, Holmes and Horvitz determined that for census tracts in Houston, Texas, there was no statistically significant correlation between geographic distribution of minority populations and rates of conventional mortgage origination. With only moderate confidence in a negative relationship between growing minority populations and falling mortgage origination, the authors conclude that the 1994 levels of bank regulation embodied in the 1968 Fair Housing Act and 1977 Community Reinvestment Act were either sufficient to curtail discriminatory lending or even too harsh to allow for the operation of an efficient market, seeing as lenders were demonstrated to be

[10] Andrew Holmes and Paul Horvitz, "Mortgage Redlining: Race, Risk, and Demand," *The Journal of Finance*, 49:1 (Mar., 1994), pp. 81-99.

allocationally rational in their study. These objections, echoed in the wake of the 1988 reforms to the CRA and repeated again throughout its ongoing history, are characteristic of economic rebuttals of government regulation of the mortgage lending market, including Macey and Miller's "The Community Reinvestment Act: An Economic Analysis," which claim that CRA restrictions disincentivize mortgage investment in poor neighborhoods. This theory, however, is at odds with the Federal Reserve documents and Neil Bhutta's above-mentioned article on the CRA, which chart a profitable and growing market in mortgage lending to low-income borrowers.

Nesiba in his 1996 article "Racial Discrimination in Housing Lending Markets," asks not why or if lending institutions or officers discriminate, but why empirical researchers and economists lack consensus upon the simple existence of systemic racial bias in lending patterns.[11] Where activists and regulators perceive tangible differences between geographic concentrations of white versus minority mortgage origination, economic analysts are satisfied to classify these trends as results of other market forces or an aberration of individual lenders' "taste for discrimination," soon to be corrected by the activity of rational market actors. The article categorizes studies of discrimination through HMDA data by four types: analysis of rejection rates, "fair share" analysis (per household loans), branch openings/closures, and regression analysis. Each of these approaches yields strong results that point to racial discrimination, but economists reject case study evidence as essentially irrelevant to the economic model of free market activity.

[11] Reynold Nesiba, "Racial Discrimination in Housing Lending Markets: Why Empirical Researchers Always See it and Economic Theorists Never Do," *Journal of Economic Issues*, 30:1 (Mar., 1996), pp. 51-77.

Methodology

This paper analyzes the success of the Community Reinvestment Act using a univariate and multi-variate regression model to determine correlation between mortgage lending rates and concentrations of minority populations in Worcester, Massachusetts in order to evaluate whether the CRA has been successful in eliminating geographic racial discrimination and to suggest potential policy changes. The methodology chosen for this project is an ordinary least squares linear regression analysis of mortgage lending rates in Worcester, Massachusetts. Although the regression model chosen does not include a spatial dimension like a geographically-weighted regression analysis, the demographic data is still mapped by census tract to allow for analysis and to offer some context for the results reached by regression.

Several demographic data sources are used in conjunction with the illustrative academic secondary sources listed above to design the study's regression analysis. To analyze impacts on an individual and systemic level in Worcester, Massachusetts, this paper focuses on three major data sources. The first data point is mortgage lending information made available under the Home Mortgage Disclosure Act (HMDA), focusing upon loans made in Worcester and specifically lending trends geographically mapped within historically red-lined census tracts in the city. Given the need for spatial data analysis listed above, this project relies upon demographic information made available through the US Census, including median income levels, poverty rates, and racial and ethnic composition of Worcester's census tracts. If the CRA is effective in disincentivizing

home lending discrimination, then the regression analysis would show a lack of correlation between minority populations in Worcester census tracts and their respective rates of mortgage origination. Finally, to assess mortgage lending risk and account for this variable in the regression model, this study uses foreclosure rates per household in Worcester's census tracts, available through the Department of Housing and Urban Development.

Regression analysis was chosen for its promise to determine the existence and strength of statistical relationships between independent variables. If the Community Reinvestment Act was completely successful in curbing discriminatory lending practices, then a univariate regression model analyzing mortgage lending rates as a dependent variable would observe no correlation with the population of African-American or Hispanic residents as independent variables in a given neighborhood. The first step therefore is to run a univariate regression model assessing the covariance of mortgage lending and racial distribution by census tract.

After this initial univariate regression analysis, it is appropriate to analyze race amongst other variables which indicate geographic distribution of lending risk, assuming that race is found to have a statistically significant relationship with lending trends. A precedent for this study (Chan et al) determined that default rates by tracts increased with the rate of foreclosure notices and the number of lender-owned properties, and these default rates in turn influenced lending rates as they indicated geographic risk to prospective lenders.[12] In order to compare the relative importance of these risk indicators

[12] Chan, Sewin, Michael Gedal, Vicki Been, and Andrew Haughwout. "The Role of Neighborhood Characteristics in Mortgage Lending Risk: Evidence from New York City," *Journal of Housing Economics*, 22:2 (June 2013), pp. 100-118.

against the impact of racial bias, this paper uses a multi-variate ordinary least squares regression analysis to examine these variables alongside race and neighborhood poverty rates and median income in bearing upon mortgage lending rates by census tract.

Each of the proposed regression analyses analyzes mortgage lending measured in dollars per capita in each census tract in the target area. This dependent variable includes two categories of mortgage lending available for public access under the Home Mortgage Disclosure Act: FHA and VA mortgages and conventional mortgages. These two categories comprise the majority of home lending investment in the study area, and further represent the vehicle of housing access and equity growth intended to be made available to minority homebuyers under the CRA.

In order to carry out a comprehensive regression analysis and construct a robust statistical model, a number of data sources were required to describe demographic and mortgage lending conditions in Worcester. Made available under the Home Mortgage Disclosure Act and published online by the Federal Financial Investigations Examination Council (FFIEC), mortgage lending data is downloadable by geography at the census tract level as opposed to the census block or block group level (where it could violate borrowers' right to privacy). With this geographic limitation, all other data chosen for this project was tailored to the census tract level where available. The HMDA lending data available organizes home lending by five categories: FHA and other government-backed loans, conventional mortgages, refinances, loans on manufactured homes, and loans on property for five or more families. While all of this data was formatted for use in the final map, this

report chose to focus on conventional mortgage lending and FHA mortgage lending as the dependent variable for analysis, as discussed above. Each category of the annually-released HMDA data includes subcategories for the number of loans of each type originated and the dollar sum of these loans by tract. After consideration the FHA and conventional mortgage value sum was used, as it encompassed mortgages of varying dollar values in Worcester's neighborhoods and thereby provided a more accurate picture of investment than raw numbers of mortgage originations. The HMDA dataset downloaded and utilized for this report was “Loans Sold, by Characteristics of Borrower and Of Census Tract in which Property Is Located And By Type of Purchaser, 2015.”

Given the geographic constraints imposed by the HMDA data, census data was downloaded to the census tract to match with mortgage lending information. This data constituted both the raw demographic data needed to determine minority populations and rates of poverty by neighborhood, but also the shapefiles needed to create the illustrative maps. The shapefiles used by the 2010 Census to determine tract boundaries are available through the Massachusetts Office of Geographic Information, and were downloaded and then cropped to the constituent tracts of the city of Worcester (7301.00 to 7331.02). In order to construct a full picture of neighborhood demographics and homeownership, three datasets were sought from the U.S. Census Bureau's online American Community Survey FactFinder for the most recent years for which estimates are available, 2014. These are the 2014 5-year estimates of Selected Economic Characteristics, Selected Housing Characteristics, and Race and Ethnicity. Downloaded for the above-mentioned census

tracts in Worcester's city limits and immediate environs, this census data describes the demographics, employment, housing, and economic conditions of the city and its surroundings. Although a total of 44 census tracts were included in the census shapefiles, two (7312.01 and 7329.02) were omitted. These two constitute the exact boundaries of Clark University and the College of the Holy Cross, both of which skew mortgage lending, demographic, and economic statistics towards their college-age populations, and were left out of calculations in the final model to account for their outlying profiles. As census estimate data, these demographic statistics have a small margin of error and can be subject to sampling errors. The office of Housing and Urban Development makes public an annual summary of foreclosures by census tract (and larger geographies), including several key indicators of risk. For the purposes of this study, HUD's estimated rate of foreclosures per conventional mortgage origination in 2015, the census' 2014 estimates of housing tenure, and the census' estimation of household median income by census tract serve together as an indicator of neighborhood risk and housing capacity to be measured against the racial characteristics of each census tract as a predictor of mortgage lending.

Although current, the HUD data on foreclosures is mapped to pre-2010 census boundaries, meaning that certain tracts in Worcester which were later split into seperate tracts due to population growth are presented as a single whole in HUD's data on housing. As a result, the regression analyses and resulting maps which utilize HUD data as the above-mentioned risk assessment merged these tracts' demographic and HMDA data. For a few demographics, this was a case of simple addition; for median values (such as the

median family income, used in regression analysis), an average of the two values was taken. Although this allows for less precision in these tracts of Worcester city, it remains statistically accurate and allows for a comparison of geographic factors of risk and race as independent variables weighing upon mortgage lending trends.

Given these datasets, a few ratios needed to be created to correct for the varying sizes and populations of census tracts in Worcester and avoid an inaccurate final model. Mortgage lending measured in dollars or origination, regardless of risk or prejudice, is naturally lower where neighborhoods have fewer households or occupants. For this reason, a ratio of conventional mortgage origination dollars per capita in each neighborhood was constructed. In addition, the final datasets were used to calculate the percentage of African-American residents and Hispanic residents per census tract rather than rely on raw numbers. With the data formatted for use and mapped to 2010 and 2000 Census boundaries in Worcester, Massachusetts, the set of univariate and multi-variate regression analyses can be run in GeoDa. The resultant outliers can be mapped in Worcester's census tracts, allowing for analysis of neighborhoods in the city where lending trends have outliers above and below the best-fit regression line. The end results of this project are a set of univariate regression analyses that model FHA and conventional mortgage lending trends in relationship to race and ethnicity by census tract in Worcester, a further set of multi-variate regression analyses that model these relationships in comparison to median income, housing tenure, and foreclosure rates, and finally a set of reference maps that depict race and mortgage trends by tract and outliers from the original univariate regression models

which depict a significant relationship between the chosen variables.

Tract #	Med Fam. Inc.	FHA per capita	Conv per capita	Foreclosures	% Black	% Hisp.	% Owner-Occ
730100	$80,054.00	$520	$260	6%	22%	6%	83%
730200	$97,908.00	$440	$360	6%	9%	9%	74%
730300	$86,682.00	$460	$80	7%	4%	6%	62%
730401	$39,375.00	$230	$60	6%	10%	32%	30%
730402	$54,602.00	$60	$190	9%	15%	23%	60%
730500	$47,318.00	$160	$40	10%	20%	12%	37%
730600	$102,649.00	$170	$380	5%	6%	6%	80%
730700	$83,362.00	$650	$440	6%	10%	11%	73%
730801	$138,125.00	$170	$670	5%	3%	3%	80%
730802	$101,750.00	$130	$240	7%	3%	1%	67%
730901	$93,370.00	$180	$270	6%	4%	8%	60%
730902	$76,622.00	$310	$130	6%	10%	7%	65%
731000	$63,131.00	$260	$170	8%	16%	12%	52%
731101	$51,875.00	$310	$150	8%	12%	24%	47%
731102	$59,417.00	$200	$180	7%	15%	9%	52%
731200	$29,228.00	$60	$60	11%	8%	42%	13%
731300	$32,369.00	$240	$30	11%	15%	48%	12%
731400	$25,660.00	$340	$70	12%	14%	51%	12%
731500	$24,980.00	$120	$70	11%	22%	47%	6%
731600	$35,956.00	$20	$80	7%	9%	5%	14%
731700	$17,762.00	$0	$130	7%	18%	28%	7%
731800	$34,458.00	$140	$70	10%	13%	33%	18%
731900	$38,516.00	$160	$10	13%	25%	27%	18%
732001	$15,432.00	$40	$0	13%	14%	69%	4%
732002	$70,804.00	$300	$170	8%	15%	11%	39%
732201	$70,391.00	$240	$40	7%	15%	6%	43%
732202	$43,289.00	$350	$130	7%	5%	7%	47%
732203	$39,506.00	$120	$0	8%	15%	12%	38%
732300	$64,115.00	$630	$270	7%	12%	10%	54%
732400	$24,318.00	$100	$30	11%	13%	42%	23%
732500	$40,278.00	$140	$0	13%	11%	38%	25%
732600	$35,861.00	$200	$0	11%	15%	40%	14%
732700	$30,500.00	$210	$0	10%	23%	24%	19%
732800	$63,183.50	$400	$340	7%	15%	8%	59%
732901	$70,779.00	$510	$120	8%	14%	18%	45%
733000	$41,100.00	$80	$50	10%	6%	36%	29%
733101	$59,063.00	$390	$90	8%	6%	11%	81%
733102	$72,576.00	$660	$190	8%	10%	17%	71%
MEAN	$56,746.43	$255.26	$146.58	8.42%	12.42%	21.03%	42.45%
MIN	$15,432.00	0	0	5%	3%	3%	4%
MAX	$138,125.00	$660.00	$670	13%	25%	69%	85%

Illustration 1: Regression Analysis Variables for Worcester, MA, 2015 (Sources: U.S. Census and HUD)

There exist some limitations to the methodology chosen for this report. First, the relatively small number of observations of the independent and dependent variables (one observation each per census tract, for a total of 38 each) makes it possible that the

regression analysis could return unreliable results or be skewed by a small set of outliers. An analysis undertaken with information available at the census block or block group level would offer a greater number of observations for analysis and thereby offer a more statistically robust model for the relationship between lending and race/ethnicity,. Expanding the number of observations would allow for analytical approaches like geographically-weighted regression, which could offer additional insight about the spatial dimensions of mortgage lending trends.

Further, as a commentary upon red-lining, this paper suffers from the lack of HOLC maps for the city of Worcester which would identify neighborhoods that historically suffered from discriminatory lending denial. These maps would strengthen the evaluation of CRA effectiveness by determining whether lending patterns had broken from the geographic boundaries of redlining that originally prompted this anti-discrimination legislation.

The case studies selected in the Review of Literature demonstrate the difficulty of separating race from other variables in determining impacts on mortgage lending. The two sets of regression analysis – first analyzing race/ethnicity alone, then in the context of other variables found relevant in the case studies – measure the relative impact of race and ethnicity against other demographic and market trends, but there are still other variables that could be collinear with race and exaggerate its impact on mortgage lending, as suggested by economic analysis included above. The statistical analysis undertaken in this paper suggests potential fruitful directions for reforming anti-discrimination programs in

home lending, but it is also possible that further analysis could uncover more statistically significant variables that bear upon home lending in Worcester.

Tract #	FHA Loans	Conventional Loans	FHA Lending ($)	FHA Lending ($)
730100	19	9	$3,133,000	$1,527,000
730200	12	11	$2,367,000	$1,964,000
730300	12	2	$2,153,000	$353,000
730401	6	2	$1,241,000	$297,000
730402	1	2	$103,000	$316,000
730500	4	1	$585,000	$153,000
730600	8	18	$1,658,000	$3,612,000
730700	23	18	$4,528,000	$3,063,000
730801	3	11	$632,000	$2,482,000
730802	1	2	$235,000	$444,000
730901	3	5	$660,000	$993,000
730902	6	3	$1,247,000	$514,000
731000	NA	NA	$2,329,000	$1,539,000
731101	7	4	$1,148,000	$570,000
731102	3	3	$525,000	$480,000
731200	NA	NA	$557,000	$502,000
731300	6	1	$881,000	$130,000
731400	8	2	$1,561,000	$309,000
731500	4	2	$544,000	$343,000
731600	1	3	$144,000	$514,000
731700	0	1	$0	$304,000
731800	5	3	$849,000	$422,000
731900	5	1	$807,000	$55,000
732001	1	0	$152,000	$0
732002	7	5	$1,350,000	$753,000
732201	4	1	$683,000	$113,000
732202	6	3	$1,090,000	$405,000
732203	2	0	$350,000	$0
732300	NA	NA	$4,949,000	$2,106,000
732400	4	2	$684,000	$227,000
732500	2	0	$285,000	$0
732600	5	0	$940,000	$0
732700	5	0	$782,000	$0
732800	NA	NA	$3,716,000	$3,175,000
732901	19	5	$3,682,000	$894,000
733000	2	2	$324,000	$216,000
733101	5	2	$834,000	$182,000
733102	9	4	$1,427,000	$412,000
MEAN	4.7	3.76	$1,293,026	$772,868
MIN	0	0	0	0
MAX	23	18	$4,949,000	$3,612,000

Illustration 2: Number and Dollar Value of FHA and Conventional Mortgage Lending in Worcester, MA, 2015 (source: HUD)

Analysis

Using the variables and constraints laid out in the Methodology section of this report, a set of regression analyses were run to test the null hypothesis that there existed no statistically significant correlation between minority population and mortgage lending rates in Worcester, Massachusetts. The first step in the regression analyses was to carry out a univariate ordinary least squares regression to examine the relationship between conventional and FHA/VA mortgage lending and rates of Hispanic and African American population, as well as to determine heteroskedacity, multicolinearity, and other errors in model strength. This initial test examined conventional mortgage lending and FHA mortgage lending measured in thousands of dollars per capita in each census tract as the dependent variables, with the percentage of African-American and Hispanic residents per census tract as explanatory variables. These univariate regressions and the multivariate regressions are reproduced in appendices A, B, and D, and the coefficients and r-squared are summarized in Illustration 3.

These initial tests (see Appendix A: Regression Analysis, Figures A-1 to A-3) were illustrative in testing the variables chosen for regression analysis and clarifying which census tract characteristics showed a linear relationship with mortgage lending rates. First, the standard error tests which determine the probability of multicollinearity, distribution errors, and heteroskedasticity returned a very low probability that the dataset in question possessed disqualifying patterns amongst data points that would suggest non-random data for three of the four univariate regression analyses. Further, the three regression models

that passed these standard error tests reported a statistically significant correlation of minority population and mortgage lending rates by census tract with varying degrees of confidence and model fitness.

* denotes P<.05	Conventional Lending Per Capita	FHA Lending Per Capita	% African-American	% Hispanic	Foreclosure Rate	Median Family Inc.	Owner-occupancy	r-squared
Regression 1	0.25*	-	-	-0.48*	-	-	-	0.31
Regression 2	-	0.34*	-	-0.4*	-	-	-	0.14
Regression 3	0.27*	-	-1.01*	-	-	-	-	0.16
Regression 4	-	0.29*	-0.27	-	-	-	-	0.01
Regression 5	-	0.06	-	0.11	0.99	-1.87	0.01*	0.36
Regression 6	0.57	-	-	0.36*	-2.74*	3.86*	0.04	0.73
Regression 7	0.05	-	0.11	-	-1.4	3.7*	-0.02	0.69
Regression 8	0.06	-	-	-	-1.3	3.47*	-	0.68
Regression 9	-	-	-0.15*	-0.11*	-	0.1*	-	0.64
Regression 10	-	-	-2261	-126.8*	-	-	1278.8	0.32
Regression 11	-	-	0.09*	0.1*	,05*	-	-	0.72

Illustration 3: Regression Analysis Results

The most robust results from the initial univariate regression analyses are those produced by the comparison of Hispanic population and conventional mortgage lending (see Illustration 1, Regression 1; and Appendix A, Figure A-1). The r-squared value for this analysis, which explains the fitness of the model, showed a value of .308, suggesting that the explanatory variable presented explained 30.8% of observed variance in the constant. Although the Hispanic demographic characteristics imputed do not fully explain the variance of mortgage lending trends, the model suggests that they alone are responsible for a third of the observed variation in conventional mortgage lending, suggesting their potential importance amongst the many factors that influence mortgage investment.

Figure A-1 (Appendix A) further shows the comparative P-values (labeled "Probability") of the constant (conventional mortgage lending per capita) and the chosen variables. The 0.00003 p-value for the independent variable – percentage of Hispanic residents in total tract population – also allows for the rejection of a null hypothesis of a coefficient equal to 0 (which would signal no observable relationship between variables). Finally, the regression analysis concludes that this robust model depicts a negatively linear relationship, with the coefficient measuring the slope of their linear relationship at -.48, with higher rates of Hispanic residents in Worcester census tracts strongly correlated with lower per capita mortgage lending.

This negative correlation is echoed with lower degrees of model fitness and probability in the regression analysis of FHA mortgage lending with Hispanic population as well as conventional mortgage lending with African-American population. The regression model analyzing FHA lending per capita in comparison to Hispanic population (Appendix A, Figure A-2) returned an r-squared of .145 and a negatively linear relationship with a coefficient of -.4. The third model, analyzing conventional lending per capita in comparison to African-American population (Appendix A, Figure A-3), shows similar results, with an r-squared of .155 and a negatively linear relationship with a coefficient of -1.01. The fourth initial univariate regression analysis, comparing FHA lending with African-American population (Appendix A, Figure A-4), failed to return a fit model (r-squared <1%) and failed to reject the null hypothesis (p-value .60), and therefore saw no statistically significant correlation between FHA lending rates and African-American

resident populations.

These initial tests recommended that further multi-variate regression analysis be completed, as two of the three tests which returned significant results had relatively low model fitness, suggesting a dearth of other relevant factors. To this end, the three independent models found to show statistically significant correlation between mortgage lending trends and minority populations (both minority populations with conventional lending, and Hispanic population with FHA lending) were tested with the other independent variables: median income, owner-occupancy, and estimated rates of foreclosure by census tract.

The regression analysis comparing FHA mortgage investment with Hispanic population, foreclosure rates, owner-occupancy, and median family income (Appendix B, Figure B-2) ultimately returned a higher r-squared (.359) than the initial univariate regression. It also returned no statistically significant correlation between FHA lending and Hispanic population, median family income, or estimated rates of foreclosure. Only rates of owner occupancy, with a p-value of .0059, demonstrated correlation, with a positively linear relationship (coefficient .01).

The same independent variables compared with conventional mortgage spending return further results contrasting with initial univariate findings. The complete model analyzing conventional lending with Hispanic population and the other above-listed variables (Appendix B, Figure B-2) returned a very high r-squared (.728) and found evidence of correlation between the dependent variable and Hispanic population (p-value .

027), foreclosure rates (.015), and median family incomes (.001). Of these, the foreclosure and median family income linear relationships conform to expectations, with a negative linear relationship (-2.556) for foreclosures and a positive linear relationship (3.858) for median income. The percentage of Hispanic residents per census tract, however, was found to have a positive linear relationship (coefficient .36) with conventional mortgage lending, while it was modeled as a strongly negative linear relationship (coefficient -.48) in the initial univariate regression. Given this variation, the multi-variate analysis (Appendix B, Figure B-4) was run again without tenure and Hispanic population. The resultant model still returned a strong linear relationship between median income and conventional lending, with an overall r-squared value of .664 as compared to .728 in regression 6. In this case, the covariance between median income (which has an extremely strong relationship with conventional mortgage lending) and Hispanic population masked the latter variable's negative relationship when analyzed alone.

Finally, the multi-variate regression for conventional lending in light of African-American population and the other above independent variables (Appendix B, Figure B-3) returned similar results to the multi-variate regression analysis of conventional lending and Hispanic population. Although the model has a high r-squared at .685, it demonstrates a statistically significant correlation only between conventional lending and median family income. This relationship is shown to be positively linear with a coefficient of 3.47.

This analysis allow for the rejection of the null hypothesis of a lack of observable relationship between race and mortgage lending in Worcester and point to a statistically

significant phenomenon of lower conventional mortgage lending investment in neighborhoods of proportionally greater African-American population and lower conventional and FHA lending in areas of proportionally greater Hispanic population. In each case, however, race was determined to have no observable relationship with FHA and conventional lending trends when analyzed alongside other demographic statistics that affect mortgage lending. In each case, it was rates of owner-occupancy and family median income respectively that demonstrated the most robust linear relationship with FHA and conventional mortgage lending in Worcester.

Findings

The regression analysis performed by this study demonstrate a link between Hispanic and African-American populations in Worcester and the geographic distribution of mortgage lending in the two major categories seen in the city: FHA and VA loans, and conventional mortgage loans. The negative linear relationship originally returned by the univariate regression analyses, however, was not confirmed by comparison to other demographic indicators of risk that affect mortgage lending, where family median income and housing tenure proved to be far more effective predictors of lending trends. The lack of evidence of race as a predictor of lending in multi-variate analysis suggests that mortgage lenders do not actively discriminate against neighborhoods with larger proportional populations of African-American or Hispanic residents, but their relationship in initial univariate analysis suggests that minority residents in Worcester still disproportionately live in neighborhoods less likely to receive home lending investment.

These results are mixed as a referendum on the CRA and government regulation in disincentivizing home lending discrimination and driving community investment. It would appear, given the multi-variate test results, that mortgage lending is not driven by the racial characteristics of neighborhoods, therefore demonstrating that the explicit racial bias of the HOLC and "red lining" is either not a likely component of lending criteria, or that there is not a consensus as to what would constitute an "undesireable" minority neighborhood in the city of Worcester today and therefore no active discrimination against borrowers there. Instead, there appears to be far more of a relationship between homeownership and income

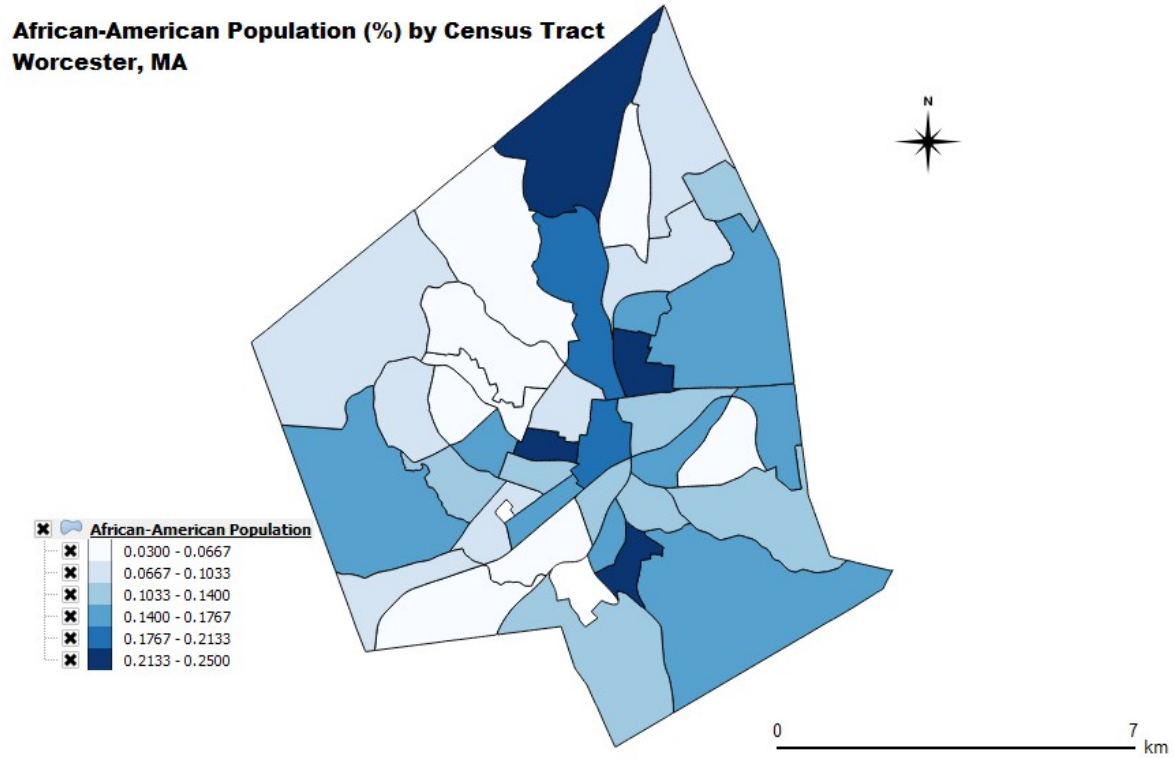

Illustration 4: African-American Population by Tract

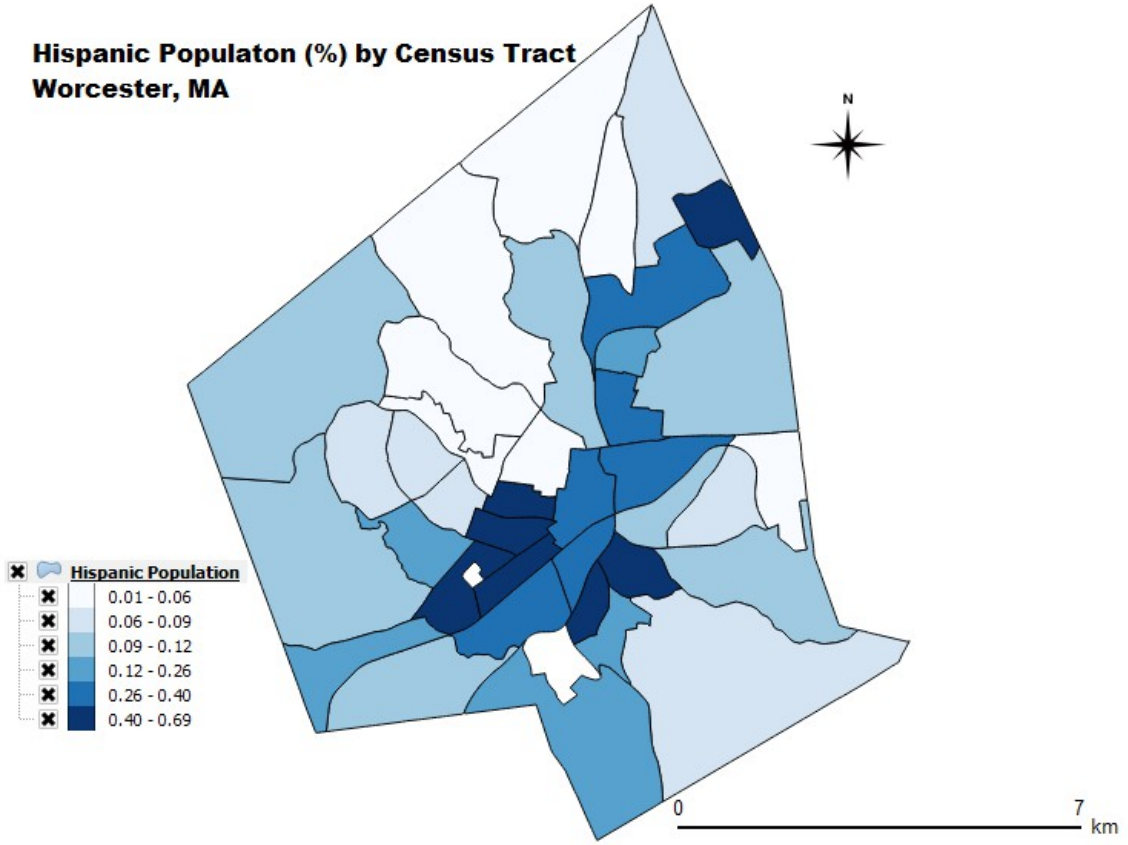

Illustration 5: Hispanic Population by Tract

and respective mortgage rates than there is between race and mortgages.

Nevertheless, the results of initial single-regression analysis suggest that government regulation has been insufficient in breaking the geographic link between communities of color and mortgage underinvestment. Within the body of literature reviewed for this paper, the study falls in the middle of the two camps of regulators and economists in analyzing mortgages through regression analysis: it successfully rejected a null hypothesis in which no statistically significant relationship existed between race and lending, unlike Horowitz et. al. and Miller et. al., but it failed to demonstrate that race or ethnicity were determinants of lending to the same extent that the Boston Fed studies could. This paper confirms the findings of Munell et. al. in their study of Boston in pointing to an explanatory covariance between race and other risk factors, which in turn affect mortgage lending.

A few explanations for the univariate findings in contrast to the multi-variate regression are possible in the context of Worcester. The first potential explanation lies in the dataset itself. With 42 mapped census tracts, three of which were merged for the foreclosure rate data, and absolute numbers of conventional mortgages relatively low citywide, there is substantial room for potential error, which is amongst the reasons why the multi-variate analysis was chosen as a second step. A larger sample population or a study area with greater mortgage lending (or aggregating several years' mortgage lending trends) could serve to create a more robust statistical model.

A second factor mentioned in the introduction of this paper is the relatively

integrated demographics of the city. Unlike the case studies by the Federal Reserve Bank in Boston and New York City, Worcester has relatively dispersed minority populations (see Illustrations 4 and 5). The proportion of African-American population from 3% of the total population (in tract 7308.02) to 25% of the total population (in tract 7319), meaning that no census tract is majority African-American citywide (see Illustration 4).

By contrast, Hispanic population varies more widely, with a 12% minimum in two tracts (7305 and 7322.05) and an outlier at 69% (tract 7320.01, which is predominantly the Greatbrook Valley public housing complex) (see Illustration 5). In addition to 7320.01, one other tract is majority Hispanic in the city (7314), and two more have Hispanic populations near 50% of the total population (7313 and 7315). It is possible that without clearly demarcated Hispanic or African-American neighborhoods, discrimination against geographically-concentrated minority populations as in historic red lining is impossible on a systemic level, and as such rates of minority populations have less observed correlation with mortgage lending that other demographic features. The above-mentioned majority Hispanic census tracts, however, constitute three of the tracts with the least conventional mortgage investment overall (including 7320.01, one of the five tracts with no conventional mortgages in 2015).

While the multi-variate regression analysis rejects race and ethnicity as significant factors related to mortgage lending trends, the maps of mortgage lending demonstrate a visible inversion between rates of African-American and especially Hispanic residents by tract and those tracts' rates of conventional lending. The tracts with the greatest

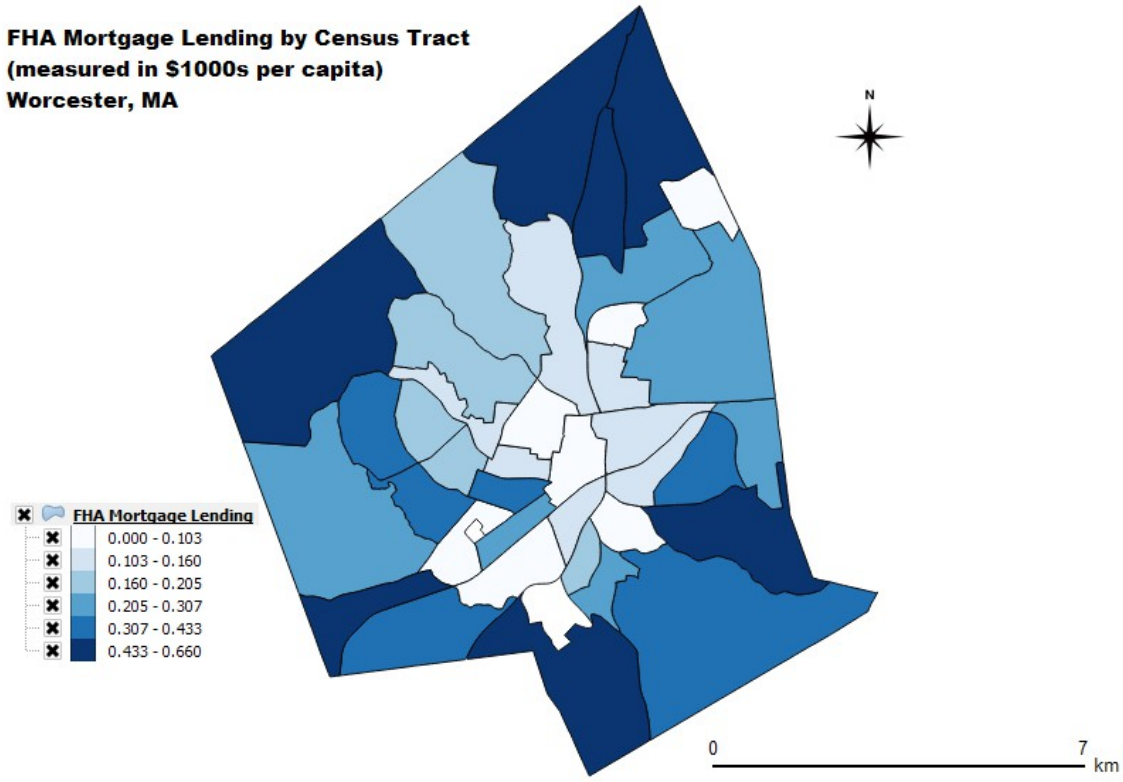

Illustration 6: FHA Lending by Tract

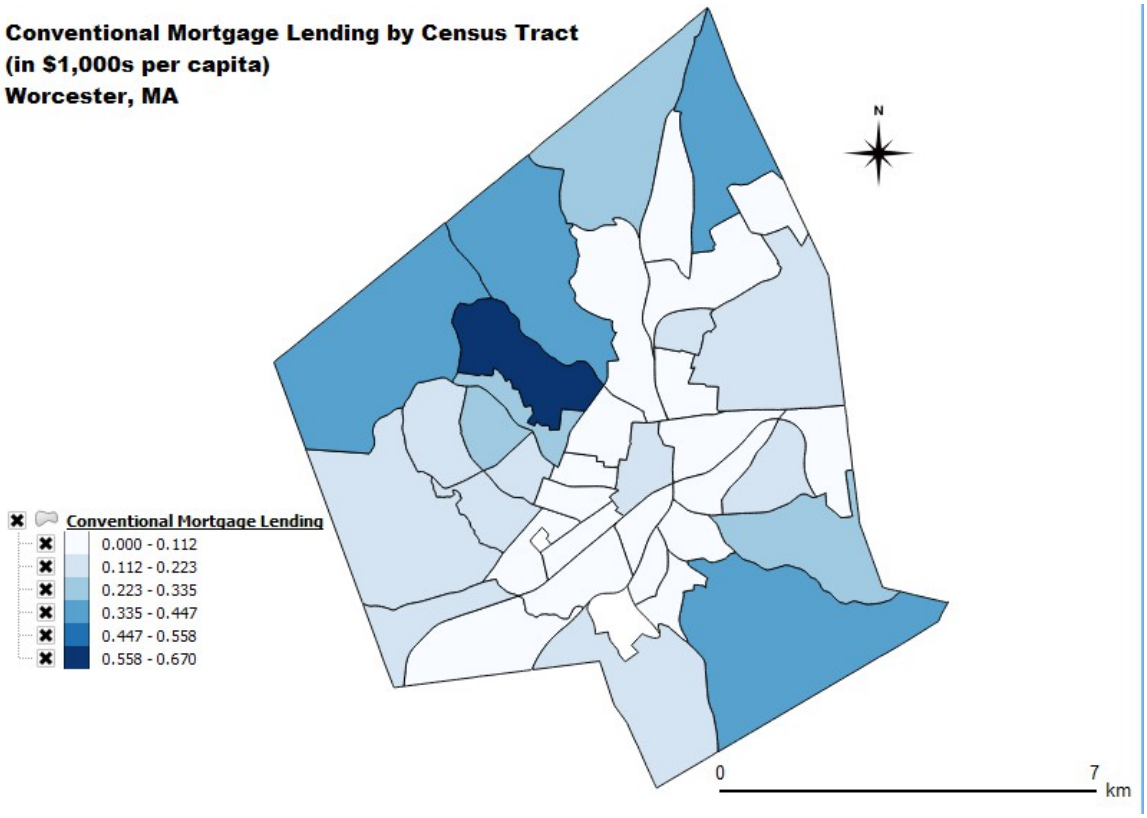

Illustration 7: Conventional Lending by Tract

proportional concentration of African-American residents fall in the continuum from North Worcester to downtown, while the majority-Hispanic tracts fall between the downtown and Main South neighborhoods.

Mortgage lending is relatively low in terms of numbers of mortgages originated and the sum of their dollar values (see Illustration 2). This is both a finding of this report and a potential limitation of this paper's approach – greater numbers of mortgages, as seen in case studies in Boston and New York, would allow for greater fidelity in modeling. Mortgage lending is far more pronounced in the peripheral tracts of the city, overlapping only with African-American population to the very north in census tract 7301. Conventional mortgage lending has an especially notable outlier in tract 7308.01, with much higher lending per capita than any other census tract in the city (see Illustrations 6-7). Finally, median family income and rates of owner-occupancy in Worcester broadly conform to the same peripheral trends observed with home lending, while the highest rates of foreclosure can be found in the central tracts of the city (Illustrations 8-10). Given this visual evidence, another explanation for the initial correlation of race and mortgage spending and its comparative weakness compared to other factors is the correlation instead between the significant risk factors used in the multi-variate regression and rates of minority population. An exploratory set of regression analyses comparing tenure and median family income with rates of minority population by census tract confirms statistically significant strongly negative linear relationships between rates of African-American and Hispanic populations and median family income (see appendix C), and

between Hispanic populations and housing tenure.

These relationships were both more strongly negative in the context of analyzing Hispanic populations citywide, and rates of Hispanic and African-American population citywide serve to explain more than 50% of observed variance in median family income and housing tenure (Appendix D, Figures D-1 and D-2). While the CRA may have been successful in curbing explicitly discriminatory lending practices in Worcester as measured in this aggregate analysis, this project makes clear the ongoing link between poverty, housing tenure, and race in the city.

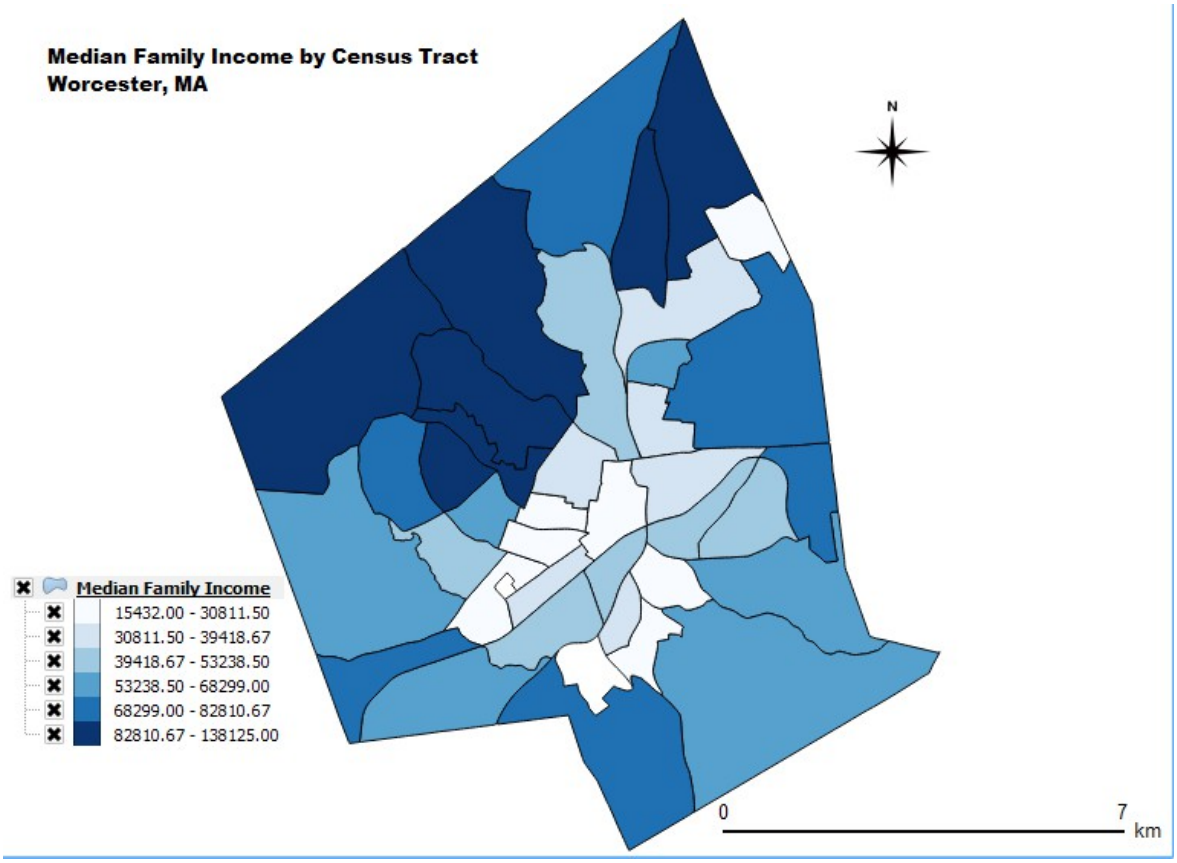

Illustration 8: Median Family Income by Tract

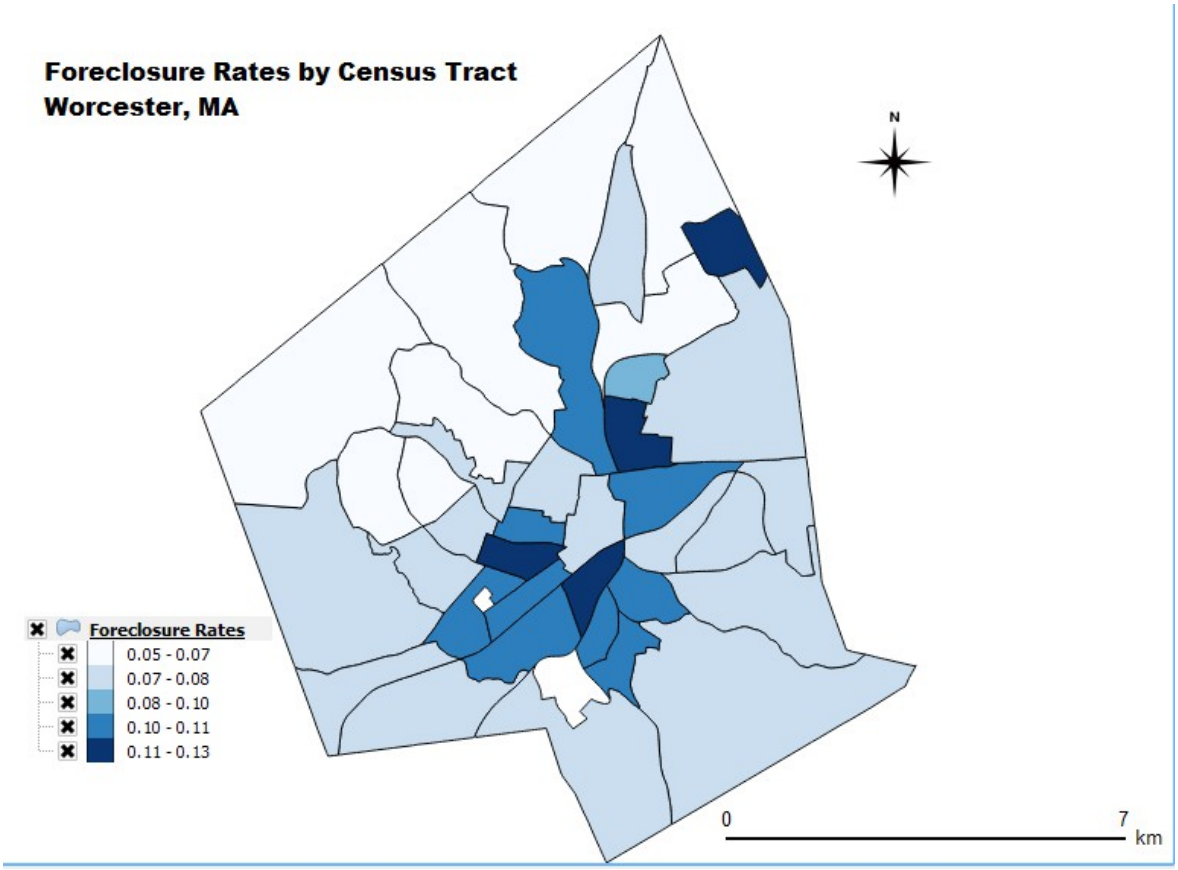

Illustration 9: Foreclosure Rates by Tract

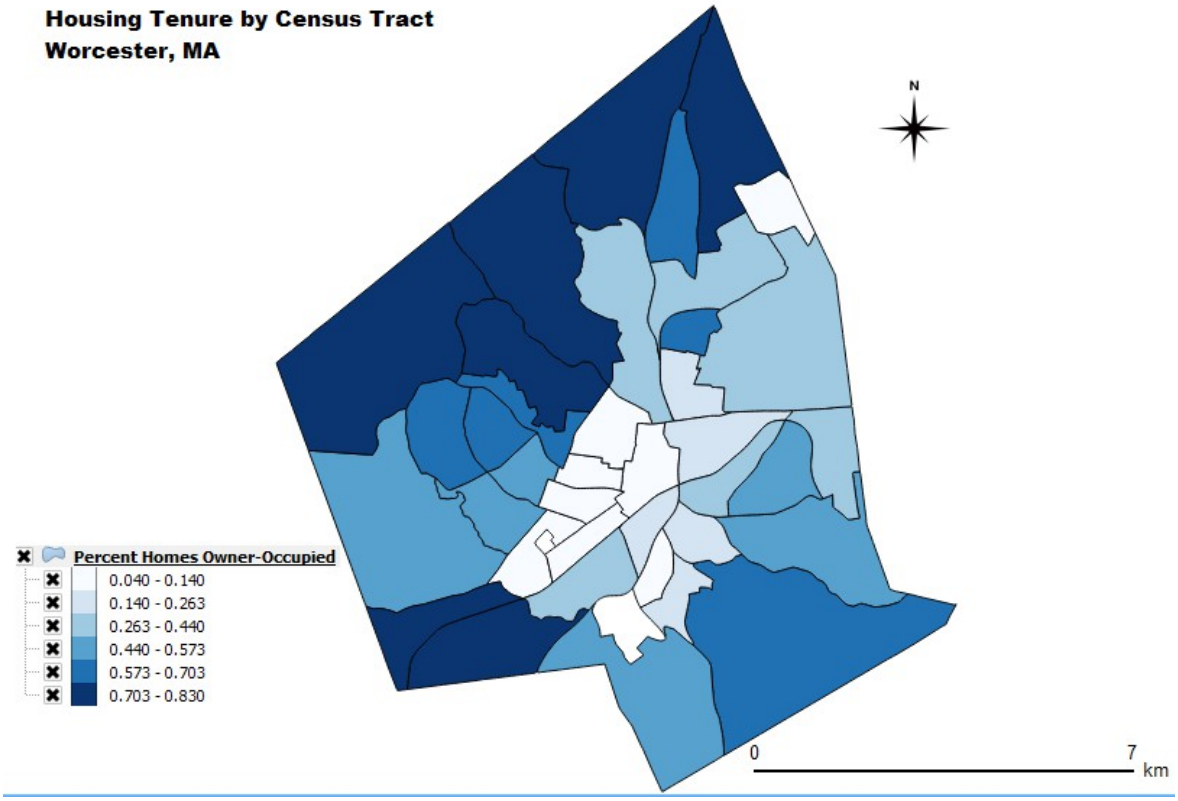

Illustration 10: Owner-Occupancy by Tract

Conclusion

Given these findings, it is the position of this paper that government intervention in the housing market or in financial aid, at least in Worcester, is necessary and should be expanded to help minority populations in the city achieve homeownership and higher median income. The comparison between FHA and conventional mortgages citywide is illustrative towards this conclusion. Conventional mortgages saw a much stronger relationship (measured in r-squared values) and a much more stark negative correlation with rates of minority population citywide when measured in univariate analysis. FHA and VA lending, meanwhile, under a government mandate to serve borrowers who might be underserved by conventional lending, saw no negative correlation with African-American population and a weakly negative correlation with Hispanic population. It is the contention of this paper, based on the data presented, that lending programs like FHA loans underwritten by the federal government are an improvement over conventional mortgage lending for minority populations who otherwise risk low rates of mortgage origination based upon the correlation between race and lending risk factors observed in census tracts.

In Worcester, policy reform suggested by the above findings could take two broad forms: expanding the reach or market share of existing FHA lending, or implementing a supplemental loan program with municipal government brokering cooperation from lending institutions, community development finance institutions (CDFIs), or community development corporations (CDCs). In Worcester, the CDCs including Main South CDC and Worcester Common Ground play a major role in developing affordable housing and

creating the opportunity for a robust housing market to develop. Given the findings suggested above where the main determinants of home lending appear to be income, foreclosure, and tenure, the role of CDCs and CDFIs can be as initial investors in a neighborhood where information externalities might make traditional lending sources more reticent to offer home loans.

The strategic goal of expanding FHA lending's market access is congruent with the national prerogatives of the FHA lending program, as outlined in HUD's 2014 "Blueprint for Access" and described in depth in the HUD 2014-2018 Strategic Plan. These documents, produced in the wake of the 2007 recession triggered by unsound subprime lending, stress the responsibility of the Department and its partnering lending institutions to serve qualified borrowers despite lingering market skittishness. "FHA is committed to finding ways to responsibly increase access for underserved borrowers," states the "Blueprint for Access."[13] The Strategic Plan confirms this commitment, and expands upon the findings of this paper. "While housing discrimination still takes on blatant forms in some instances," the authors explain, "it has become more subtle and sophisticated through the years, resulting in underreporting and complicating effective enforcement."[14] Given a regulatory environment in which outright discrimination is less common, but race and poverty remain closely intertwined, HUD proposes a set of strategies aimed at ensuring compliance with FHA lending prerogatives and increasing minority homeownership

[13] -, "Blueprint for Access." *Federal Housing Administration* (May 2014), http://portal.hud.gov/hudportal/documents/huddoc?id=BlueprintAcess5_9_2014.pdf.

[14] -, "Strategic Plan 2014-2018." *U.S. Department of Housing and Urban Development* (April 2014), http://portal.hud.gov/hudportal/documents/huddoc?id=hudstrategicplan2014-2018.pdf.

opportunities, including improved outreach initiatives and increased education for FHA lenders to ensure their cooperation in this effort.

As HUD already appears broadly responsive to the general trends noted by this project, the policy directives for local government would involve communicating with the federal department in order to implement the technical assistance outlined in the first HUD fair housing strategy (Strategic Objective 4a). As a HUD grantee, Worcester is eligible for such technical assistance in support of achieving fair lending goals. Routes for implementation under the HUD 2014-2018 Strategic Plan include grant funding under The Partnership for Sustainable Communities and possibly through the Strong Cities, Strong Communities Initiative. These programs include funding for municipal government to carry out outreach in support of FHA lending.

Communication of FHA home loan opportunities would appear vital in Worcester given the disproportionately low home lending observed in majority Hispanic communities. While the univariate analyses returned negative correlations between minority populations and conventional mortgage lending in the city, the single variable test for FHA lending demonstrated no correlation between lending patterns and proportions of African-American residency by tract. Instead, it returned a weak negative correlation with the proportion of Hispanic population , demonstrating that to some degree the FHA program has failed to reach Hispanic residents of Worcester. It is therefore plausible that some reform or expansion of FHA outreach, whether in strategic approach or language access, could improve FHA lending trends in Hispanic communities in Worcester.

Another policy approach at the municipal level would be to organize a consortium of FHA lenders to coordinate compliant mortgage lending with a measure of direction from City government. In Worcester, there are a list of eleven total FHA licensed lenders who could benefit from a coordinated approach, as well as larger banks across Massachusetts who offer FHA loans. While it is important that the City not hinder market competitiveness, it would still be possible for the city to suggest plausible strategic imperatives such as outreach or program reform as listed above which would improve the reach, effectiveness, and the ultimate return of FHA compliant lending. In Worcester, a similar consortium exists in the Worcester Business Development Corporation (WBDC), which includes board members and institutional partners from financial institutions citywide aimed at fostering local economic development. It is possible – albeit a significant undertaking – that the strategic vision of the WBDC could be expanded to include fair and affordable housing amongst its goals, or a complementary consortium could be formed to support fair lending in the Worcester.

The above-mentioned policy reforms build upon existing success while acknowledging shortcomings in the CRA and the program of FHA lending. The regression analysis completed by this project suggests the continued struggle of minority communities to achieve mortgage lending and homeownership at the same rates as non-minority counterparts in Worcester. This, as noted by the HUD Strategic Plan, is less the result of blatant racial discrimination observable within the context of other lending risks as much as it is a result of continued failures to de-couple geographic concentration of poverty,

short-term housing tenure, and minority population in Worcester and many other American urban contexts. The CRA and FHA are ultimately means to an end – shared economic prosperity for peoples of every race and class in the United States. Although functional in curbing discrimination and incentivizing opportunities for homeownership where otherwise unavailable, these programs have far to go in order to achieve their ultimate aim.

Appendix A: Univariate Regression

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REGRESSION
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SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :  merged
Dependent Variable  :  CON000PERC  Number of Observations:   38
Mean dependent var  :    0.146579  Number of Variables   :    2
S.D. dependent var  :    0.143917  Degrees of Freedom    :   36

R-squared           :    0.155275  F-statistic           :     6.61744
Adjusted R-squared  :    0.131811  Prob(F-statistic)     :   0.0143692
Sum squared residual:    0.664845  Log likelihood        :     22.9503
Sigma-square        :   0.0184679  Akaike info criterion :    -41.9006
S.E. of regression  :    0.135897  Schwarz criterion     :    -38.6254
Sigma-square ML     :   0.0174959
S.E of regression ML:    0.132272

------------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
------------------------------------------------------------------------------
          CONSTANT      0.272812      0.0537957        5.07125     0.00001
            PERCAA      -1.01628       0.395065       -2.57244     0.01437
------------------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   4.666149
TEST ON NORMALITY OF ERRORS
TEST                 DF           VALUE             PROB
Jarque-Bera           2            10.8717          0.00436

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                 DF           VALUE             PROB
Breusch-Pagan test    1             3.9720          0.04626
Koenker-Bassett test  1             2.4852          0.11492
================================ END OF REPORT ================================
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Figure A-1: Single Variable Regression Analysis comparing rates of Conventional Mortgage Lending (measured in thousands of dollars per capita) and rates of Hispanic population (measured as a percentage of total population) by census tract in Worcester,

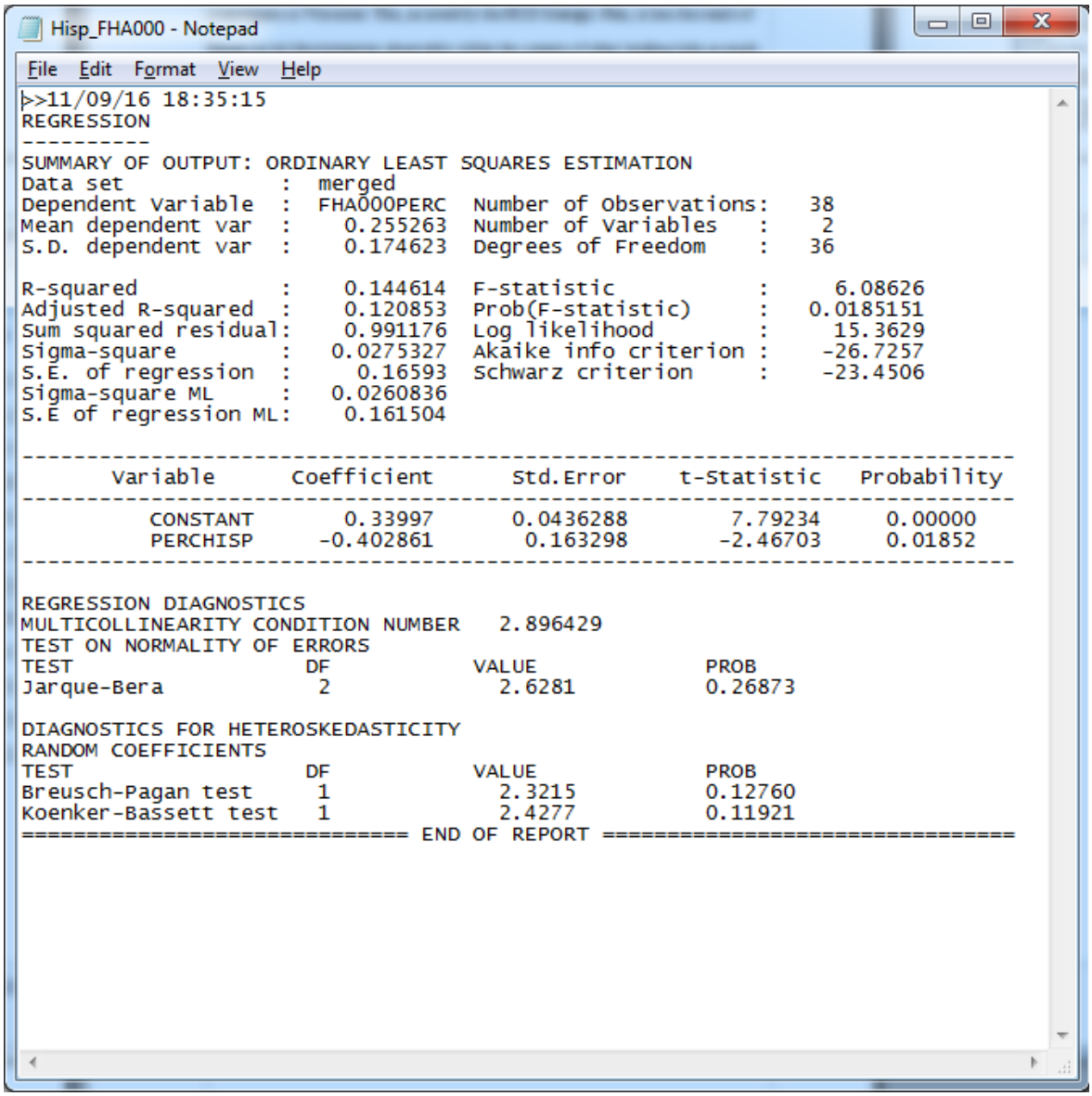

Figure A-2: Single Variable Regression Analysis comparing rates of FHA Mortgage Lending (measured in thousands of dollars per capita) and rates of Hispanic population (measured as a percentage of total population) by census tract in Worcester, MA.

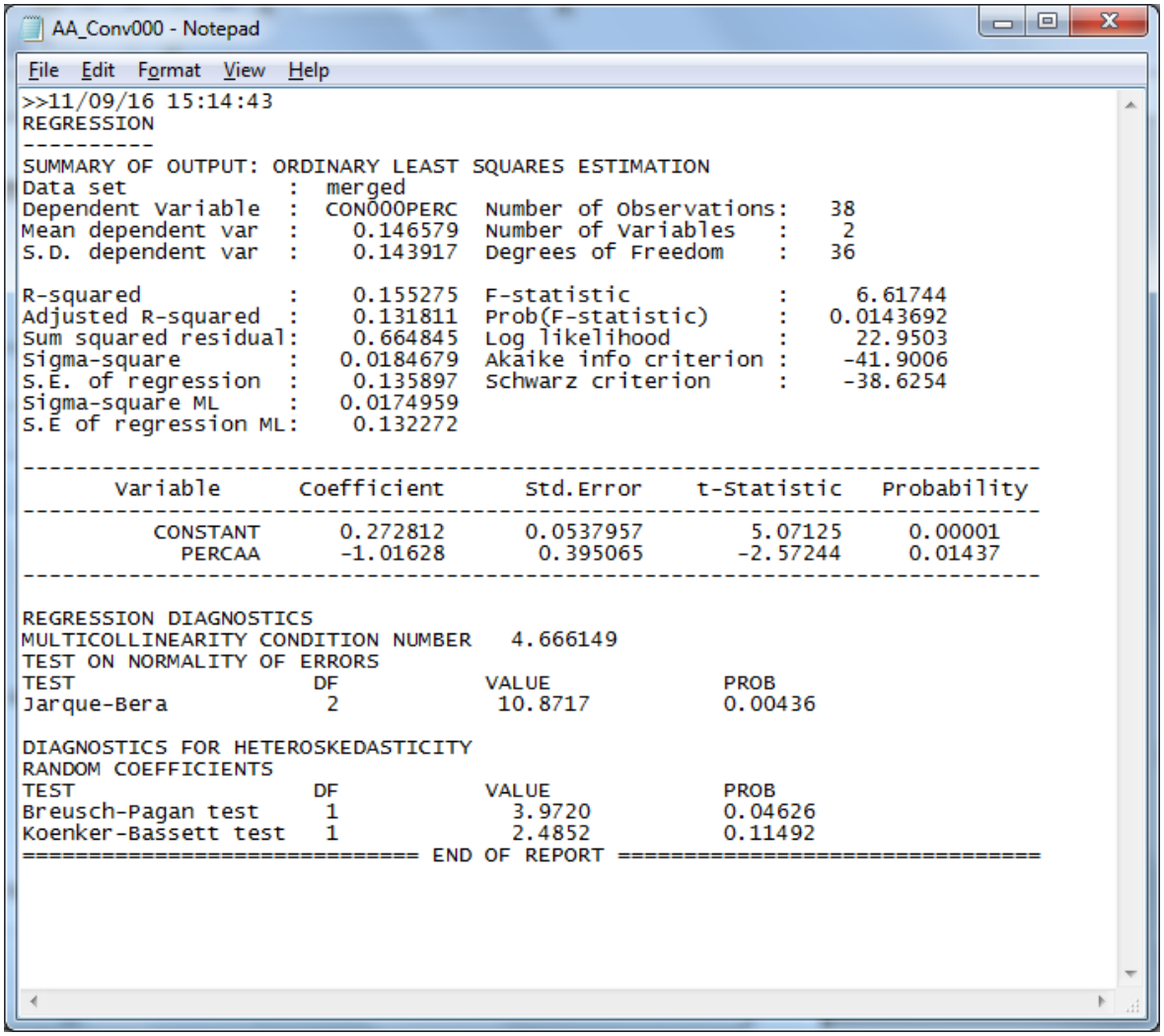

Figure A-3: Single Variable Regression Analysis comparing rates of Conventional Mortgage Lending (measured in thousands of dollars per capita) and rates of African-American population (measured as a percentage of total population) by census tract in Worcester, MA.

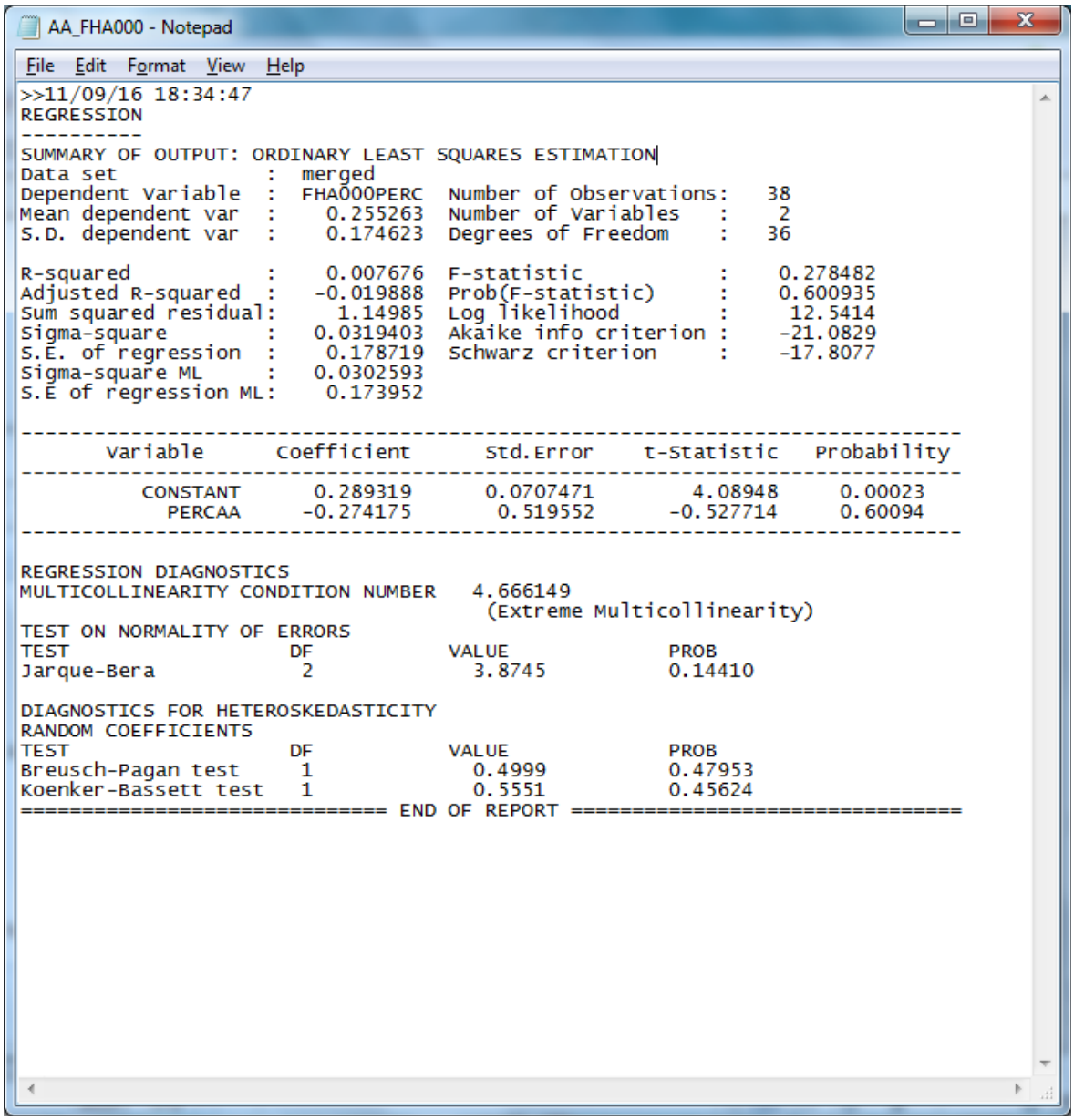

Figure A-4: Single Variable Regression Analysis comparing rates of FHA Mortgage Lending (measured in thousands of dollars per capita) and rates of African-American population (measured as a percentage of total population) by census tract in Worcester, MA.

Appendix B: Multi-variate Regression

Hispanic_FHAPlus - Notepad

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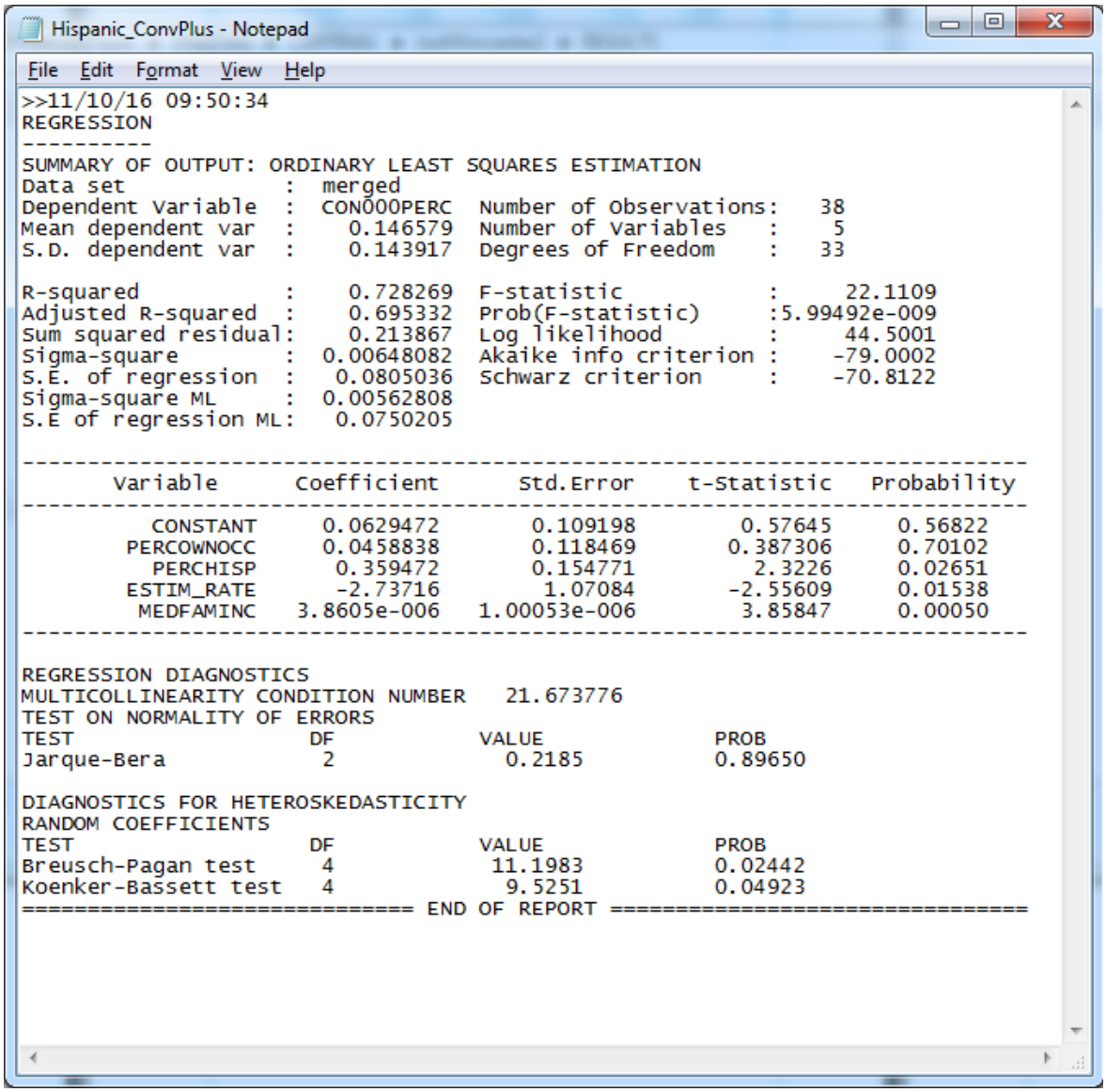
```
>>11/10/16 09:31:23
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :  merged
Dependent Variable  :  FHA000PERC  Number of Observations:   38
Mean dependent var  :    0.255263  Number of Variables   :    5
S.D. dependent var  :    0.174623  Degrees of Freedom    :   33

R-squared           :    0.359386  F-statistic           :     4.62827
Adjusted R-squared  :    0.281736  Prob(F-statistic)     :   0.0044624
Sum squared residual:     0.74231  Log likelihood        :     20.8563
Sigma-square        :   0.0224942  Akaike info criterion :    -31.7125
S.E. of regression  :    0.149981  Schwarz criterion     :    -23.5246
Sigma-square ML     :   0.0195345
S.E of regression ML:    0.139766

------------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
------------------------------------------------------------------------------
          CONSTANT     0.0609888       0.203439       0.299788     0.76622
        PERCOWNOCC      0.652907       0.220712        2.95819     0.00568
          PERCHISP      0.112118       0.288344       0.388832     0.69990
        ESTIM_RATE    0.00237859        1.99501     0.00119227     0.99889
         MEDFAMINC  -1.87927e-006   1.86401e-006       -1.00819     0.32070
------------------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   21.673776
TEST ON NORMALITY OF ERRORS
TEST                     DF           VALUE             PROB
Jarque-Bera               2             0.7499          0.68733

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                     DF           VALUE             PROB
Breusch-Pagan test        4             3.9960          0.40655
Koenker-Bassett test      4             4.1170          0.39040
================================ END OF REPORT ================================
```

Figure B-1: multi-variate Regression Analysis comparing rates of FHA Mortgage Lending (measured in thousands of dollars per capita) and housing tenure (measured in percent of owner-occupied housing units), Hispanic population (measured as a percentage of total population), the percentage rate of foreclosures, and median family income by census tract in Worcester, MA.

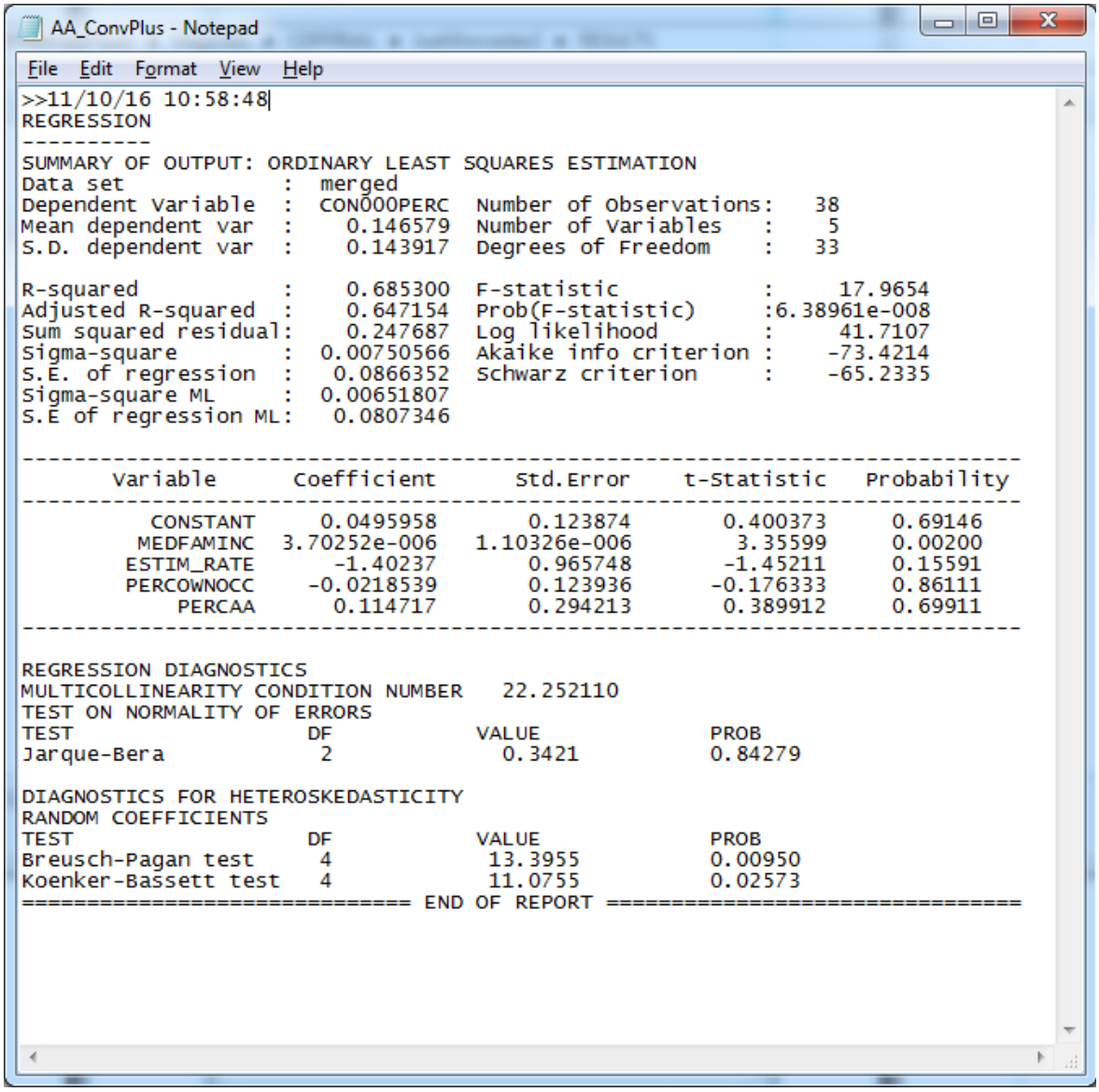


Hispanic_ConvPlus - Notepad

File Edit Format View Help

```
>>11/10/16 09:50:34
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :  merged
Dependent variable  :  CON000PERC  Number of Observations:   38
Mean dependent var  :    0.146579  Number of Variables   :    5
S.D. dependent var  :    0.143917  Degrees of Freedom    :   33

R-squared           :    0.728269  F-statistic           :     22.1109
Adjusted R-squared  :    0.695332  Prob(F-statistic)     :5.99492e-009
Sum squared residual:    0.213867  Log likelihood        :     44.5001
Sigma-square        :  0.00648082  Akaike info criterion :    -79.0002
S.E. of regression  :   0.0805036  Schwarz criterion     :    -70.8122
Sigma-square ML     :  0.00562808
S.E of regression ML:   0.0750205

------------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
------------------------------------------------------------------------------
          CONSTANT     0.0629472       0.109198        0.57645     0.56822
        PERCOWNOCC     0.0458838       0.118469       0.387306     0.70102
          PERCHISP      0.359472       0.154771         2.3226     0.02651
        ESTIM_RATE      -2.73716        1.07084        -2.55609     0.01538
         MEDFAMINC   3.8605e-006   1.00053e-006         3.85847     0.00050
------------------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   21.673776
TEST ON NORMALITY OF ERRORS
TEST                     DF            VALUE              PROB
Jarque-Bera               2              0.2185           0.89650

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                     DF            VALUE              PROB
Breusch-Pagan test        4             11.1983           0.02442
Koenker-Bassett test      4              9.5251           0.04923
================================ END OF REPORT =================================
```

Figure B-2: Multi-variate Regression Analysis comparing rates of Conventional Mortgage Lending (measured in thousands of dollars per capita) and housing tenure (measured in percent of owner-occupied housing units), Hispanic population (measured as a percentage of total population), the percentage rate of foreclosures, and median family income by census tract in Worcester, MA.



AA_ConvPlus - Notepad

File Edit Format View Help

```
>>11/10/16 10:58:48
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :  merged
Dependent variable  :  CON000PERC  Number of Observations:   38
Mean dependent var  :    0.146579  Number of Variables   :    5
S.D. dependent var  :    0.143917  Degrees of Freedom    :   33

R-squared           :    0.685300  F-statistic           :    17.9654
Adjusted R-squared  :    0.647154  Prob(F-statistic)     :6.38961e-008
Sum squared residual:    0.247687  Log likelihood        :    41.7107
Sigma-square        :  0.00750566  Akaike info criterion :   -73.4214
S.E. of regression  :   0.0866352  Schwarz criterion     :   -65.2335
Sigma-square ML     :  0.00651807
S.E of regression ML:   0.0807346

------------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
------------------------------------------------------------------------------
          CONSTANT     0.0495958       0.123874       0.400373     0.69146
         MEDFAMINC  3.70252e-006   1.10326e-006        3.35599     0.00200
        ESTIM_RATE      -1.40237       0.965748       -1.45211     0.15591
        PERCOWNOCC    -0.0218539       0.123936      -0.176333     0.86111
            PERCAA      0.114717       0.294213       0.389912     0.69911
------------------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   22.252110
TEST ON NORMALITY OF ERRORS
TEST                 DF            VALUE              PROB
Jarque-Bera           2              0.3421           0.84279

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                 DF            VALUE              PROB
Breusch-Pagan test    4             13.3955           0.00950
Koenker-Bassett test  4             11.0755           0.02573
================================ END OF REPORT ================================
```

Figure B-3: Multi-variate Regression Analysis comparing rates of Conventional Mortgage Lending (measured in thousands of dollars per capita) and housing tenure (measured in percent of owner-occupied housing units), African-American population (measured as a percentage of total population), the percentage rate of foreclosures, and median family income by census tract in Worcester, MA.

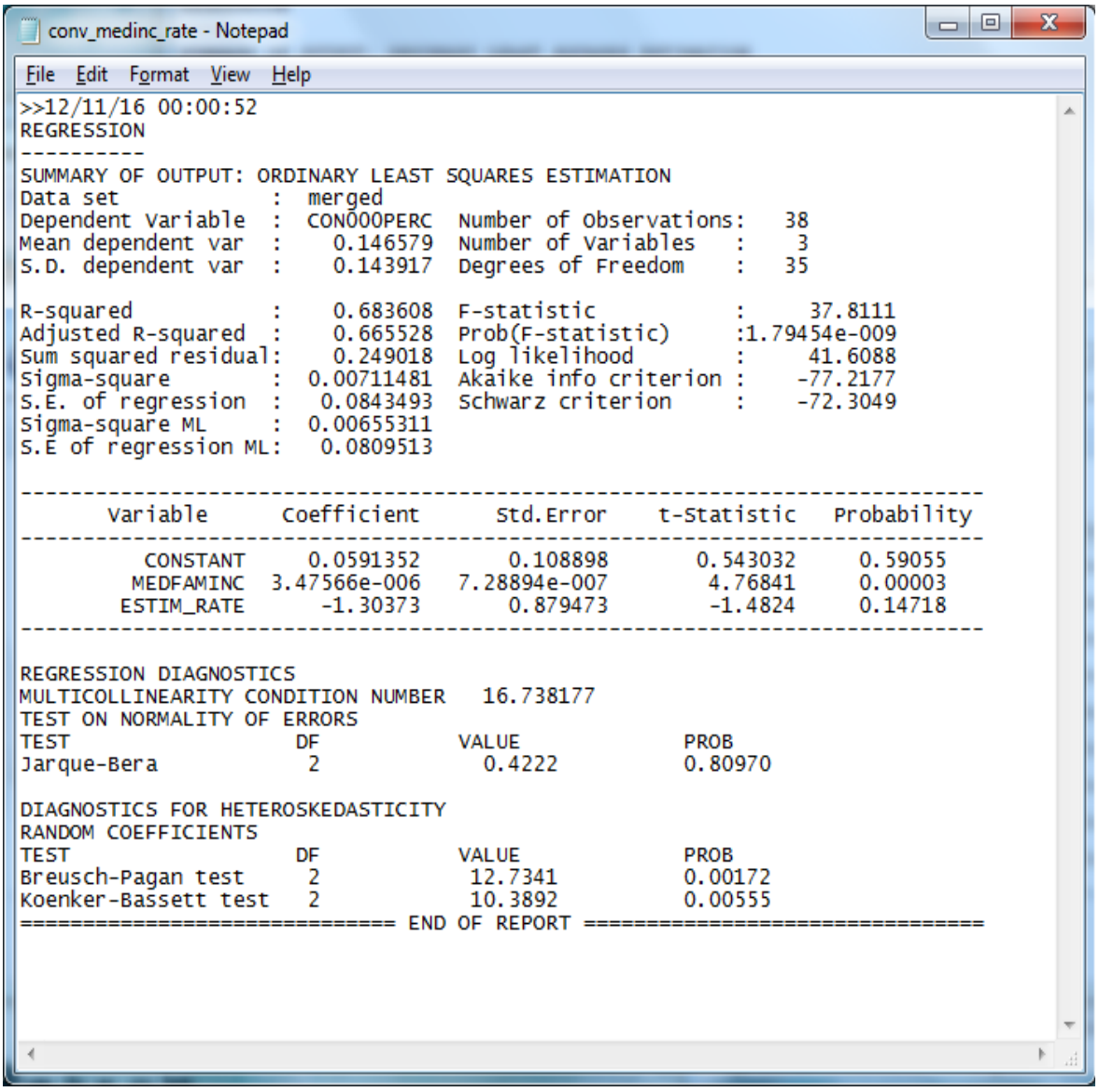
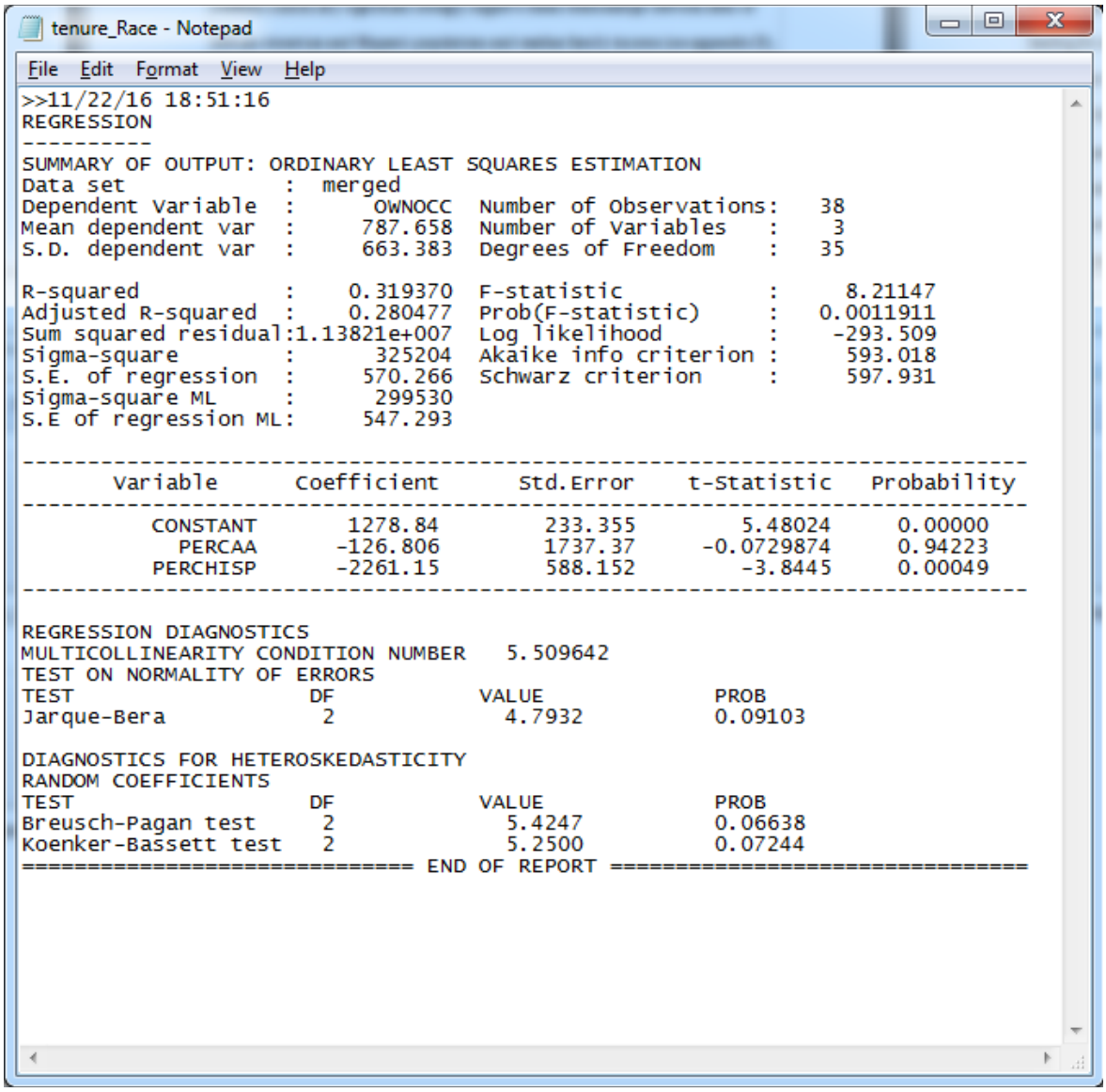


Figure B-4: univariate Regression Analysis comparing rates of Conventional Mortgage Lending (measured in thousands of dollars per capita), estimated foreclosure rate, and median family income by census tract in Worcester, MA.

Appendix D: Univariate Regression: Race/Ethnicity and Tenure, Median Income



tenure_Race - Notepad

File Edit Format View Help

```
>>11/22/16 18:51:16
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :  merged
Dependent variable  :     OWNOCC  Number of Observations:   38
Mean dependent var  :    787.658  Number of Variables   :    3
S.D. dependent var  :    663.383  Degrees of Freedom    :   35

R-squared           :   0.319370  F-statistic           :    8.21147
Adjusted R-squared  :   0.280477  Prob(F-statistic)     :  0.0011911
Sum squared residual:1.13821e+007  Log likelihood        :   -293.509
Sigma-square        :     325204  Akaike info criterion :    593.018
S.E. of regression  :    570.266  Schwarz criterion     :    597.931
Sigma-square ML     :     299530
S.E of regression ML:    547.293

------------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
------------------------------------------------------------------------------
          CONSTANT       1278.84        233.355        5.48024      0.00000
            PERCAA      -126.806        1737.37     -0.0729874      0.94223
          PERCHISP      -2261.15        588.152        -3.8445      0.00049
------------------------------------------------------------------------------

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER    5.509642
TEST ON NORMALITY OF ERRORS
TEST                     DF            VALUE              PROB
Jarque-Bera               2              4.7932           0.09103

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                     DF            VALUE              PROB
Breusch-Pagan test        2              5.4247           0.06638
Koenker-Bassett test      2              5.2500           0.07244
================================ END OF REPORT =================================
```

Figure D-1: multi-variate Regression Analysis comparing housing tenure (measured as percentage of owner-occupied housing units) and Hispanic and African-American population (measured as a percentage of total population) by census tract in Worcester, MA.

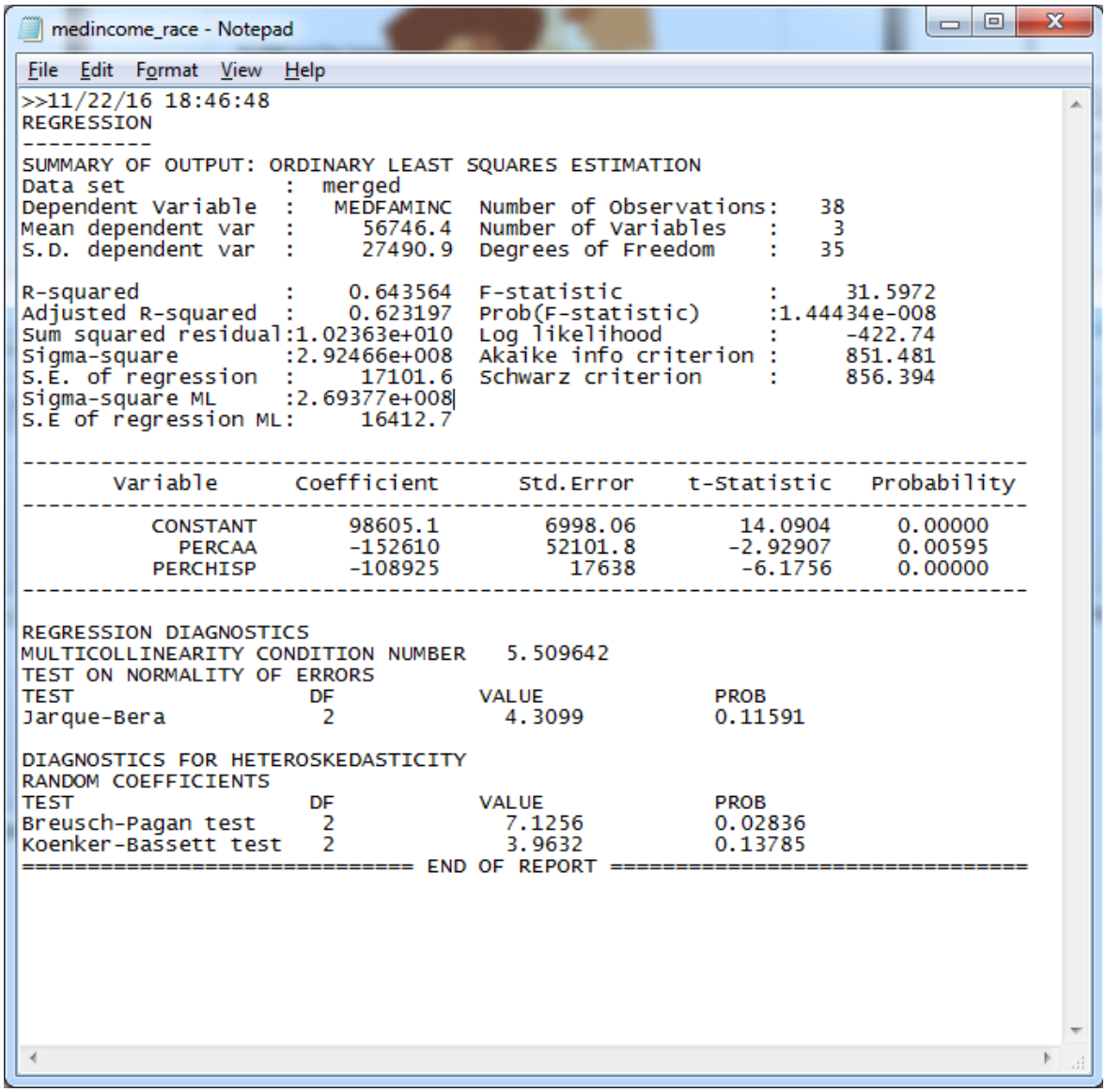


Figure D-2: multi-variate Regression Analysis comparing median family income and Hispanic and African-American population (measured as a percentage of total population) by census tract in Worcester, MA.

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