

Information Externalities and Residential Mortgage Lending in the Hardest Hit Housing Market: The Case of Detroit

Lei Ding

Federal Reserve Bank of Philadelphia¹

Abstract

The flow of credit to the residential sector is a critical issue in the recovery of the housing market after the Great Recession. This study revisited the effect of the “information externality” from previous transactions on lending decisions during the housing crisis in a hard-hit market of the Detroit metropolitan area. The results of the study suggest that the lack of previous mortgage-financed sales and the concentration of foreclosures in a neighborhood present significant challenges for the access to credit for many mortgage applicants in Detroit. The significant effect of information externality is primarily relevant to the conventional mortgage market and the effect has a relatively low threshold: when the number of mortgage purchases is five or fewer in the previous year, the odds of denial increase 32 percent. More than 30 percent of the neighborhoods in the Detroit metropolitan area have been adversely affected by the lack of accurate information on neighborhood home sales prices. Results from this case study shed light on the systematic process of property valuation and mortgage underwriting during the recent housing crisis.

¹ This article was submitted for publication before the author joined the Federal Reserve Bank of Philadelphia. The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

Introduction

To help explain the disparity observed in residential mortgage lending across neighborhoods, Lang and Nakamura (L-N) (1993) suggest that the level of housing market sales represents an “information externality” for future lending decisions in the corresponding neighborhood. According to the L-N theory, market activities measured by total loan volume reduce the uncertainty associated with the appraised value of a property and thus affect future loan decisions. A sufficient volume of market sales aids in price discovery, which provides more certainty about home values, enables lenders to distinguish observable risks, and leads to an increased supply of loans. By contrast, an insufficient number of mortgage originations could lead to greater uncertainty in house price appraisals, and as a result mortgage seekers are more likely to be denied because the homes’ value cannot be determined accurately. Moreover, because the home sales pricing information generated by a particular lender is publically disclosed and all lenders benefit from it, individual lenders have little incentive to help facilitate loan transactions and gain a better understanding of market values. In other words, the market failure because of information externality could lead to equilibrium with suboptimal lending.

In the aftermath of the Great Recession, information externality is an important topic to examine in the residential mortgage market. Two information issues have become evident in many markets. First, many transactions have been sales of distressed properties, which may not provide suitable information for the valuation of a more normal market transaction. The preponderance of distressed home sales in certain neighborhoods may lead valuation estimates to be biased downward when they are used as comparable properties without appropriate adjustments. Second, transaction volume has been low for a variety of reasons. The lack of market sales, especially mortgage-financed home sales, may lead to high degrees of uncertainty in appraisals. Lenders may require a larger downpayment because of the uncertainty in the appraisal to ensure that borrowers have a sizeable equity stake. And when borrowers are unable or unwilling to come up with extra payment, lenders may deny the loan. If loans are not originated, transactions may not occur, and the true value of properties will not be determined. Since the Great Recession, no known research has examined how previous transactions influence future lending decisions through information externalities.

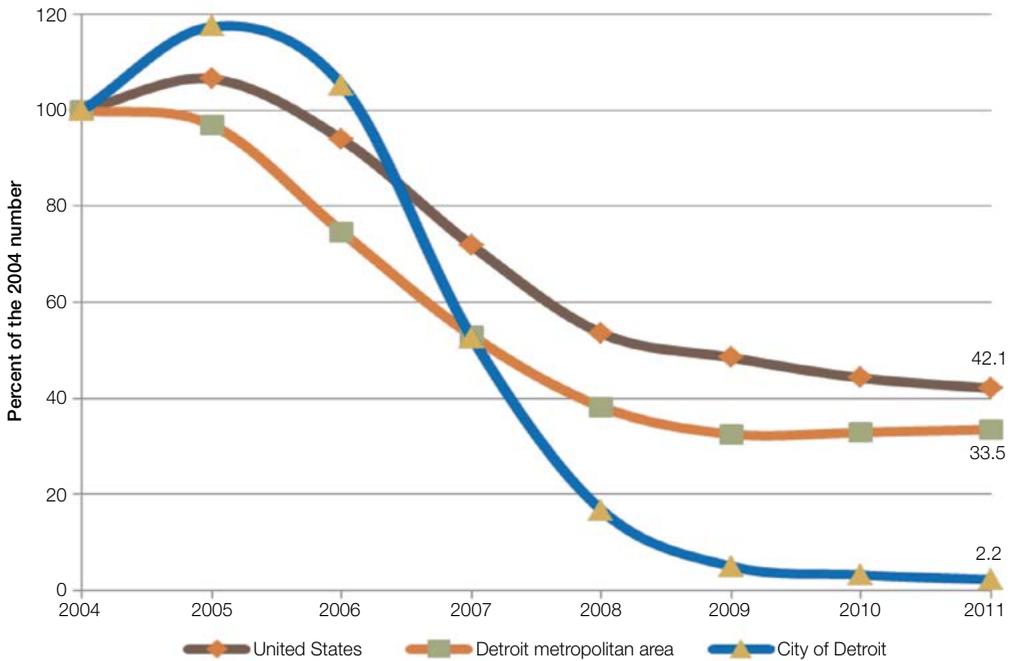
This study focuses on one of the hardest hit housing markets in the nation—the Detroit metropolitan area (hereafter, Detroit).² Having experienced a collapse in its housing sector, Detroit provides a unique opportunity for this empirical study. On the one hand, Detroit has many relatively strong neighborhoods,³ primarily in the suburban areas, which have recorded relatively few foreclosures and have comparatively stable housing and mortgage markets. On the other hand, mortgage lending has nearly dried up in most neighborhoods in the city of Detroit and some neighborhoods in its suburbs, likely due to the regional economic recession and the aftermath of the recent housing crisis (exhibit 1). Most home sales prices available for comparison in these more challenged neighborhoods

² This article considers the Detroit Tri-County Area (Macomb, Oakland, and Wayne Counties) as the Detroit metropolitan area, which had a population of 3.86 million in 2010, or about 90 percent of the population in the six-county U.S. Office of Management and Budget definition of Detroit-Warren-Livonia, MI Metropolitan Statistical Area (MSA) (4.3 million in 2010).

³ Consistent with most early studies, *neighborhood* is defined as census tract. Considering the size of the neighborhood used by appraisers, census tract is a more appropriate geographic area for the analysis. The data are also readily available at the tract level in the Home Mortgage Disclosure Act.

Exhibit 1

Purchase Mortgage Originations in the United States, Detroit Metropolitan Area, and City of Detroit



Note: First-lien home purchase loans only.

Source: Home Mortgage Disclosure Act data

are from foreclosed properties, Real Estate Owned (REO) properties, or cash sales. Thus, Detroit provides a full spectrum of neighborhoods in terms of different lending volumes and foreclosure concentrations.

To investigate the effect of the information externality provided by previous transactions on lending decisions during the 2010-to-2011 period in Detroit, the study examines whether prior lending volume and foreclosure rates in Detroit help explain lenders' decisions. Overall, the regression results confirm the existence of significant information effects in the Detroit market and that the effect is primarily relevant to conventional lenders and neighborhoods with a limited number of mortgage originations. If the number of purchase originations is five or fewer in the previous year, the odds of denial increase 32 percent. In fact, more than 30 percent of all neighborhoods in the Detroit metropolitan area, including nearly all neighborhoods in the city of Detroit, have been adversely affected by the lack of valid information on neighborhood home sales prices.

Evidence shows that previous foreclosures and delinquencies are important to estimating the empirical importance of information externalities. Neighborhood mortgage default rates are associated with higher probability of mortgage denial, likely because they are correlated with unobservable

risks of borrowers and neighborhoods or because foreclosures depressed home sales prices and appraised values. Additional research is needed to better understand the mechanisms of the effect of prior foreclosures.

Overall, the findings generally support the information externality theory in a radically changing environment. This study also demonstrates the importance of considering information externality from distressed home sales in information externality studies. Although the current analysis does not test explicitly the relationship between information externalities and the long-term suboptimal lending equilibrium, the correlation between past mortgage origination volume and current lending decisions is consistent with the information externality theory. Because of the information externality issue, there could be a reason for justifying government intervention in housing markets that have potential demand but face serious problems in obtaining information on home sales prices.

Background

To provide the background and context to the present study, this section provides an overview of role of appraisal in the mortgage lending process and reviews the empirical evidence of the effect of the information externality and other neighborhood characteristics on mortgage lending decisions.

The Role of Appraisal in the Mortgage-Lending Process

Among a variety of factors lending institutions use in making mortgage loan decisions, a comparison of the loan amount to the market value of the home is an important consideration. Such a comparison is important because the risk of a typical mortgage is connected to the level of equity in the property.⁴ And the equity stake of a mortgage at origination, usually measured by the loan-to-value (LTV) ratio, reflects the credit risk of a mortgage application. The precise value of the home on the market consequently provides crucial information to the mortgage lender, which influences both the likelihood that the mortgage will default and the options that the mortgage lender has if the borrower falls behind in making payments.

Because of the critical importance of the property value for the lender's lending decision, creditors usually require home value appraisals or other home value estimates to determine the true value of a home. The lender typically contracts a third party to provide an independent appraisal because the lender cannot rely on the home's selling price alone as a measure of the collateral value of a property (Hutto, 2003). The appraiser estimates the probable market value of the property by taking into account the neighborhood characteristics, the condition and improvements to the home, and recent home sales prices of comparable homes in the area.⁵ In practice, lenders usually use the lesser of the property's sales price and appraisal value as the value of the property and use it in

⁴ According to the option theory, the borrower has the incentive to default when he or she has a negative equity in the property (Foster and Van Order, 1984; Quercia and Stegman, 1992; Vandell, 1995).

⁵ A property appraiser is tasked with making judgments based on market research and analysis to develop a "credible value opinion." Appraisers are required to consider all relevant transactions that have occurred in the market area and determine transactions that are the best comparable home sales to the property being appraised. Finally, the appraiser needs to make adjustments for material differences between each comparable and the subject property.

the calculation of LTV ratios (Nakamura, 2010). So the appraisal value and the difference between the appraisal value and the contract price are important considerations in underwriting residential mortgages.

In theory, an appraisal should reflect the true market value of the property. Appraisals are often biased, however, and could be significantly different from a home's true market value. For example, the fallout from the recent housing bubble raised questions about the accuracy of appraisals before the housing crisis. Several studies suggest that appraisals have often been biased upward and made mortgages riskier before and during the subprime boom (Cho and Megbolugbe, 1996; Leventis, 2006). When they do not have to bear the loss from default, lenders or the agents of the lenders may have an incentive to lean on appraisers to inflate values to make loans more attractive for resale on the secondary market. When appraisals are inflated, lenders may lend too much money relative to the home's actual value and, when this happens, mortgage defaults are more likely. LaCour-Little and Malpezzi (2003) used a small sample of mortgages from Alaska in the 1980s and found appraisal bias is positively associated with higher default risk.

A set of new and tighter regulations on appraisal practices has been adopted since 2009 (Murphy, 2012). The 2009 Home Valuation Code of Conduct (HVCC) was designed to ensure the independence of appraisers from the influence of lenders, brokers, and agents when appraising properties. Later, the Dodd-Frank Wall Street Reform and Consumer Protection Act⁶ included a sunset provision for the HVCC, as well as other changes to the regulation of real estate appraisals.⁷ With the tightened regulation of appraisals and the likely overreaction by lenders and appraisers, the bias of an appraisal could go the other way, causing home valuation to be underestimated, especially in some distressed markets (Nakamura, 2010; Steinke, 2012).

A low appraisal likely leads to higher rates of denial and withdrawal of mortgage applications. First, a low appraisal may force the homeowner to sell the property at a price lower than the agreed-upon contract price.⁸ If the homeowner is unwilling to accept the new price, the sale could be canceled. Second, a low appraisal may push the lender to require a larger downpayment. When the borrower is capital constrained, this may cause the lender to reject the mortgage application. The result is that a low appraisal could make it more difficult for a sound borrower to conclude a home purchase. Third, a homeowner who wishes to upgrade or expand his or her home is unable to secure the financing if the appraisal for the property, including the improvements, is too low. All these challenges resulting from a low appraisal can introduce substantial uncertainty into the homebuying process, increase the likelihood of withdrawal or denial of mortgage applications, and derail home sales and disrupt the plans of homebuyers and sellers.

⁶ Public Law 111-203, H.R. 4173.

⁷ The Act requires a property visit for appraisals of a home financed by a high-risk mortgage, conditions for a second appraisal at no cost to the home purchaser, mandated independence for appraisers, portability of some residential property appraisals, rules for customary and reasonable fees, standards for appraiser education, and a mandatory annual report to Congress by the Appraisal Subcommittee on its activities.

⁸ For example, in Grandmont Rosedale, one of Detroit's strongest and most vibrant communities, appraisals had been on average 10 percent lower than the agreed upon sales price in the first half of 2011, and they nearly always resulted in a loss of sale or, at best, a home sold at below market value (SEMCOG, 2012).

Information Externality and the Accuracy of Home Appraisals

Appraisals may often be different from contract prices because they are related to many factors related to market conditions, neighborhood quality, appraisers' subjective judgment, and other factors that may affect property values (LaCour-Little and Green, 1998). As Nakamura (2010) pointed out, however, appraisals could become systematically inaccurate for three reasons: low volume of home sales, foreclosures, and bias. Discussed previously, the L-N's information externality theory explains how previous mortgage-financed transactions affect lenders' lending decisions: The volume of home sales affects the accuracy of appraisals and uncertainty may now be causing home appraisals to be biased too low; furthermore, low appraisals that result from few recent home sales affect the loan decision.

Several empirical studies, based either on national representative data or on data for particular metropolitan areas, provide evidence generally in support of the L-N theory (Avery, Beeson, and Sniderman, 1999; Blackburn and Vermilyea, 2007; Calem, 1996; Harrison, 2001; Ling and Wachter, 1998). Calem (1996) used nationwide Home Mortgage Disclosure Act (HMDA) data from 1990 to 1991 to explore the relationship between mortgage-lending decisions and recent home sales. He found that fewer transactions are associated with a higher rate of loan rejections; the mortgage denial rate for White households increases as the number of home sales increases in the corresponding county. Blackburn and Vermilyea (2007) provided the most comprehensive empirical test using data from loan application files from eight large banks. The authors controlled applicants' credit-worthiness in their test of information externalities in a mortgage-lending model. The results suggest that information externalities are relevant for about 10 percent of the applications for mortgages in neighborhoods with less than 20 home sales in the previous year. They found evidence supporting the presence of an internal effect (scale of economy) of information on underwriting decisions. Their sample is quite small (2,065 mortgage loans), however, and it is uncertain whether the conclusions could apply in the after-crisis markets.

Uncertainty because of low home sales volume is not the only source of low appraisals. The recent housing crisis resulted in markets with significant proportions of distressed properties and collapsed housing prices. The sales prices of distressed or foreclosed homes tend to be substantially lower than nondistressed market sales, often as a result of the increased time and risk associated with distressed home sales, differences in the condition of the properties, and the seller's motivation in completing the transaction (Campbell, Giglio, and Pathak, 2011; Forgey, Rutherford, and VanBuskirk, 1994; Hardin and Wolverton, 1996; Pennington-Cross and Ho, 2010). Consistent evidence generally suggests that foreclosed properties have a negative spillover effect on the values of properties in the surrounding neighborhood (for example, Immergluck and Smith, 2006; Lin, Rosenblatt, and Yao, 2009; Schuetz, Been, and Ellen, 2008). Distressed property sales continue to be recorded, however, and could be used as comparable properties in appraisals of nondistressed properties, which may cause a downward drag on estimates of home sales prices and affect would-be homebuyers' ability to secure financing.⁹ This issue becomes more serious when distressed home sales become much more prevalent in neighborhoods where appraisers may not be able to find enough sales of nondistressed homes to provide a good estimate of normal home sales.

⁹ According to the Appraisal Institute (2008), an appraiser should not ignore foreclosure sales if consideration of such home sales is necessary to develop a credible value opinion. Only home sales that might have involved atypical seller motivations (for example, a highly motivated seller), such as a short sale, could be ignored. Of course, an adjustment for foreclosed properties based on property condition, sales concessions, and seller motivations may also be needed.

Neighborhood Effects on Mortgage Lending

Overall neighborhood characteristics such as socioeconomic factors may also influence mortgage-lending activities, which are often considered to be neighborhood effects. In the early 1990s, researchers conducted studies that tested the lending disparities in the mortgage market, and some studies have tested the associations among neighborhood incomes, racial components, and center city location with mortgage lending at the aggregate level (for example, Munnell et al., 1996; Tootell, 1996; see review in Ladd, 1998). Although not quite as conclusive as suggested by Schill and Wachter (1993), these studies generally found strong associations between neighborhood characteristics and mortgage denial rates. Another group of studies demonstrated that neighborhood characteristics, in addition to borrower-specific risks, are significantly correlated with mortgage performance (Berkovec et al., 1998; Calem, Gillen, and Wachter, 1999). Ross and Yinger (2002) moved the debate forward by providing a comprehensive analysis of lending disparities across borrowers and neighborhoods.

During the subprime boom, it appeared that subprime lending targeted many of the same neighborhoods that had previously been at risk of redlining by prime lenders (known as *reverse redlining*). Research on subprime lending patterns suggests that subprime lending disproportionately occurs among minority borrowers or within neighborhoods where minority and low-income households predominate (for example, Calem, Gillen, and Wachter, 2004; Ding et al., 2008).

In fact, the study of the neighborhood effects on mortgage lending is analogous to an even larger body of literature on the neighborhood effects of various social and economic outcomes. In addition to mortgage lending, neighborhood racial transitions, property values, and sociodemographic dynamics have been documented to change in nonlinear or threshold-like ways in response to changes in the neighborhood context (Galster, 2012; Quercia and Galster, 2000).

Overall, evidence in the literature suggests that certain neighborhoods disproportionately have high mortgage denial rates or a greater share of high-risk lending. Information externalities provided by previous mortgage-financed purchases in the neighborhood could help explain such patterns; however, the empirical tests of the L-N theory have been limited to the effect of home sales volume only and are based on data collected before the Great Recession. The current study revisits the information externality issue and explores how it applies to the residential housing market in Detroit, which has experienced significant policy changes, along with ever-changing market conditions.

Data and Methodology

The study presented in this article uses a set of logistic regression models in which the dependent variable is the mortgage application decision, equal to 1 if denied and 0 if approved. Denial has drawn most of the attention in lending outcomes analysis because it captures both the demand- and supply-side forces. This analysis focuses on 66,238 first-lien home purchase loan applications¹⁰ in 2010 and 2011 in Detroit. For simplification, the term *purchase loans* is used to represent first-lien home purchase loans for owner-occupied one- to four-unit homes.

¹⁰ This sample size is for the preferred model. The sample size for other models may be slightly different because of the use of a different dependent variable or the missing value generated by the logarithmic transformation of the information variables.

The data primarily come from three sources: HMDA, the census, and the U.S. Department of Housing and Urban Development (HUD). First, measures on the characteristics of mortgage applicants and previous mortgage lending (mortgage originations in the previous year) were constructed based on HMDA data. HMDA data represent the universe of mortgage applications, with some exceptions for small lenders and lenders located outside a metropolitan statistical area.¹¹ HMDA provides mortgage application and origination information, in addition to rich information on borrower demographics, the geographic location of the property securing the loan (census tract), and limited loan characteristics. Applications that were approved and originated, applications that were denied, and applications that were approved but not accepted by the applicant are included in the analyses.¹²

Information variables, such as the measures of lending activity in the tract, are constructed based on HMDA data. Assuming that the amount of recent loan activity is more relevant, this study uses the number of mortgage purchases in the year before the mortgage application as the period during which updating might occur.¹³ The relationship between the odds of denial and approved mortgage applications is expected to be nonlinear, with diminishing returns to the information provided from previous transactions. This nonlinearity is accounted for by incorporating these variables either in log form or by using a set of categorical variables.

Second, HMDA data are complemented by information on tract characteristics that might be relevant to mortgage lending from the census. Information on census tract characteristics is obtained from the 2010 census and the 5-year average of the U.S. Census Bureau's 2006–2011 American Community Survey, which roughly is the time period for mortgage applications reviewed in the study.

Third, this analysis uses data from other sources to construct proxies of neighborhood foreclosure rates and the creditworthiness of an average applicant, which are important contributions of this study. The neighborhood foreclosure data are from HUD. In 2010, HUD calculated tract-level foreclosure need scores, based on the estimated rate of loans in foreclosure or delinquency (90 or more days) in March 2010 to help community groups and organizations to geographically target Neighborhood Stabilization Program 3 assistance.¹⁴ The foreclosure need score data from HUD

¹¹ Although HMDA's coverage for lending by small depository institutions and for lending in the rural areas is quite limited, the coverage of HMDA for MSAs is quite complete. Because this study focuses on the more densely populated areas within an MSA, coverage should not be an issue.

¹² Eight possible outcomes for a loan application in HMDA include (1) loan originated, (2) application approved but not accepted, (3) application denied by financial institution, (4) application withdrawn by applicant, (5) file closed for incompleteness, (6) loan purchased by financial institution, (7) preapproved request denied by financial institution, and (8) pre-approval request approved but not accepted. This study primarily focuses on the first three, except that the outcome of withdrawal (application withdrawn by applicant) was considered in one specification.

¹³ Cash transactions are not considered in the preferred model because of the following considerations: (1) cash transactions are usually more prevalent in the low-value markets in which mortgage financing is less likely needed; (2) some cash purchases, especially those bulk transactions by investors, have different motivations than those of regular housing market sales; (3) cash transactions could go unreported; and (4) different from mortgage transactions, no public data sources are available for cash transactions. The information variable becomes insignificant when considering all transactions based on observations in the city of Detroit.

¹⁴ The foreclosure need score (the serious delinquency rate) from HUD is estimated using the tract rate of subprime loans from 2004 to 2007, the increase in the unemployment rate between March 2005 and March 2010, and the decline in home values from peak to the first quarter of 2010.

provide a useful indicator of the mortgage default rate (or risk) for a given neighborhood. This study also uses the tract average credit score of all mortgage borrowers in the same neighborhood from 2005 to 2008 as a proxy for applicant creditworthiness.¹⁵ Although the lack of direct control of individual borrowers' credit risk could be a potential shortcoming of the analysis, considering this proxy of average credit scores of previous purchasers should help address this concern. This proxy is similar to the control of neighborhood credit risk that was used in several empirical studies (for example, Calem, Gillen, and Wachter, 2004; Ding et al., 2011).

Measures of other controls include median household income, minority population percentages, the ratio of median monthly rent to median house value, owner-occupied housing stock, and the prevalence of owner-occupied and vacant units (see exhibit 2 for definitions of variables and descriptive statistics). The bank-level effect is addressed by incorporating dummies for major lenders, as suggested by Blackburn and Vermilyea (2007).

Exhibit 2

Variable Definition and Descriptive Statistics (1 of 2)

Variable	Data Source	Variable Definition	Mean
denial	HMDA	1 if denied, 0 if originated or approved but not accepted	0.197
pctinc	HMDA	Household income as a percentage of area median	1.256
fha	HMDA	Application of FHA or conventional mortgage	0.533
other race or missing	HMDA	Non-Hispanic borrower with missing info for race	0.121
Black	HMDA	Non-Hispanic Black borrower	0.104
Hispanic	HMDA	Hispanic borrower	0.019
White borrower	HMDA	Non-Hispanic White borrower	0.756
owner_occupied	HMDA	Owner occupied property or not	0.938
medinc	2007–2011 ACS	Tract median income (\$ thousands)	72.104
owner_units (log)	2010 census	Total owner-occupied units (in log)	7.124
rent_to_value	2007–2011 ACS	Median monthly rent to median house value	0.596
vac_rate	USPS	Share of housing units vacant in March 2010	0.024
pct_black	2010 census	Share of tract residents Black	0.104
pct_his	2010 census	Share of tract residents Hispanic	0.029
pct_asian	2010 census	Share of tract residents Asians	0.042
pct_poverty	2007–2011 ACS	Share of households under poverty	0.087
pct_owner	2010 census	Share of tract house unit owners	0.806
tract del rate (high)	HUD	Serious delinquency/foreclosures rate >17% in March 2010	0.319
tract del rate (med)	HUD	Serious delinquency/foreclosures rate 14–17% in March 2010	0.472
fico_score_0508	Black Knight	Average credit score for prior mortgage borrowers (2005–08) in the neighborhood	706.6
2010_applications	HMDA	2010 purchase loan application	0.501
Detroit	HMDA	Properties in Detroit or not	0.020
prior_orig (in log)	HMDA	Number of mortgage purchases in the previous year (in log)	3.549
prior_app (in log)	HMDA	Number of purchase loan applications in the prior year (in log)	3.960
prior_orig 0–5	HMDA	0–5 mortgage purchases in a census tract in prior year (%)	0.021
prior_orig 6–10	HMDA	6–10 mortgage purchases in a census tract in prior year (%)	0.026

¹⁵ The average credit score is calculated based on a merged dataset of proprietary national representative mortgage data and HMDA data. Because the subprime products have been largely eliminated since the housing crisis, the average credit score is calculated for first-lien mortgages without risky features (negative amortizations, low or no doc, prepayment penalties, or balloon payments).

Exhibit 2**Variable Definition and Descriptive Statistics (2 of 2)**

Variable	Data Source	Variable Definition	Mean
prior_orig 11–15	HMDA	11–15 mortgage purchases in a census tract in prior year (%)	0.048
prior_orig 16–20	HMDA	16–20 mortgage purchases in a census tract in prior year (%)	0.083
prior_orig 21–25	HMDA	21–25 mortgage purchases in a census tract in prior year (%)	0.116
prior_orig 26–30	HMDA	26–30 mortgage purchases in a census tract in prior year (%)	0.121
prior_orig 31–50	HMDA	31–50 mortgage purchases in a census tract in prior year (%)	0.317
lender 1	HMDA	Lender 1	0.269
lender 2	HMDA	Lender 2	0.053
lender 3	HMDA	Lender 3	0.044
lender 4	HMDA	Lender 4	0.044
lender 5	HMDA	Lender 5	0.043
lender 6	HMDA	Lender 6	0.041
lender 7	HMDA	Lender 7	0.041
lender 8	HMDA	Lender 8	0.032
lender 9	HMDA	Lender 9	0.030
lender 10	HMDA	Lender 10	0.025
other lenders	HMDA	Other smaller lenders	0.593
Number of observations			66,238*

ACS = American Community Survey. Black Knight = Black Knight Financial Services, Inc. FHA = Federal Housing Administration. HMDA = Home Mortgage Disclosure Act. HUD = U.S. Department of Housing and Urban Development. USPS = United States Postal Service.

*The descriptive statistics are based on the study sample used by the preferred model (Model 2 in exhibit 3).

Note: First-lien purchase loan applications of one- to four-unit family housing in 2010 and 2011 in the Detroit metropolitan area (Macomb, Oakland, and Wayne Counties).

Empirical Results

Several sets of the logistic regression models are used to identify the impact of prior lending volume and foreclosures on mortgage-lending decisions. Exhibits 3 and 4 summarize results from logistic regression models using previous mortgage purchases or mortgage applications as the information variables, respectively. Exhibit 5 summarizes results for the conventional and Federal Housing Administration (FHA) and Department of Veterans Affairs (VA) markets, respectively, using the categorical information variables only. Model 1 uses the log of prior mortgage purchases (or applications) as the information variable, while Model 2 uses a set of categorical variables to identify the threshold effect of the information variable. Finally, an insufficient number of prior mortgage purchases could increase the probability of both mortgage denial and borrower withdrawal. Model 3 tests this contention by using application denial or withdrawal as the dependent variable.

The results in exhibit 3 provide statistical support for the existence of information externality effects. Mortgage purchases are statistically significant when entered in logarithmic form (Model 1). When categorical variables are used, the results suggest that the information externality is primarily relevant up to five purchase mortgage originations; the odds of denial increase 32 percent if the number of previous mortgage purchases is no greater than five. This threshold is much lower than the 20 home sales identified in Blackburn and Vermilyea (2007), which focused on mortgage lending before the recent housing crisis. The lower threshold partly reflects the generally much lower level of transactions during the study period. The increase in the overall denial rates may also help explain the results.

Exhibit 3

Logistic Regression Results Based on the 2010–11 Applications in Detroit With Denial As the Outcome (home purchase loans)

Variable	Model 1 (denial)			Model 2 (denial)			Model 3 (denial/withdrawal)		
	Estimate	SE	OR	Estimate	SE	OR	Estimate	SE	OR
intercept	-0.697	0.431		-0.668	0.454		-0.394	0.388	
pctinc	-0.001***	0.000	0.999	-0.001***	0.000	0.999	-0.001**	0.000	0.999
fha	-0.039***	0.012	0.925	-0.036***	0.011	0.931	-0.038***	0.010	0.926
race (other race)	0.121***	0.028	1.438	0.119***	0.028	1.439	0.142***	0.025	1.425
race (Black)	0.178***	0.032	1.522	0.174***	0.032	1.520	0.130***	0.028	1.408
race (Hispanic)	-0.057	0.054	1.203	-0.048	0.054	1.217	-0.059	0.047	1.166
owner-occupied	-0.275***	0.041	0.760	-0.276***	0.041	0.759	-0.243***	0.036	0.784
medinc	-0.001	0.001	0.999	-0.002	0.001	0.998	-0.001	0.001	0.999
owner_units (in log)	-0.026	0.038	0.974	-0.059	0.037	0.943	-0.058	0.032	0.944
rent_to_value	-0.070	0.045	0.932	-0.065	0.045	0.937	-0.053	0.038	0.949
vac_rate	0.007	0.005	1.007	0.010**	0.005	1.010	0.011**	0.004	1.011
pct_black	0.006***	0.001	1.006	0.006***	0.001	1.006	0.006***	0.001	1.006
pct_his	0.008**	0.004	1.008	0.007	0.004	1.007	0.007**	0.003	1.007
pct_asian	0.005**	0.002	1.005	0.005**	0.002	1.005	0.004**	0.002	1.004
pct_poverty	0.014***	0.002	1.014	0.014***	0.002	1.014	0.014***	0.002	1.014
pct_owner	0.004***	0.001	1.004	0.005***	0.001	1.005	0.004***	0.001	1.004
tract del rate (high)	0.101***	0.024	1.264	0.095***	0.024	1.251	0.065***	0.020	1.171
tract del rate (med)	0.033**	0.015	1.182	0.034**	0.015	1.177	0.027**	0.013	1.126
fico_score_0508	-0.001	0.000	0.999	-0.001	0.000	0.999	0.000	0.000	1.000
2010 dummy	0.011	0.012	1.023	0.010	0.012	1.019	0.004	0.010	1.008
Detroit dummy	0.198**	0.088	1.219	0.200**	0.089	1.222	0.167**	0.082	1.182
prior_orig (in log)	-0.070***	0.023	0.932						
prior_orig 0–5				0.197***	0.069	1.321	0.128**	0.063	1.194
prior_orig 6–10				0.025	0.053	1.112	0.011	0.047	1.063
prior_orig 11–15				-0.022	0.041	1.061	-0.006	0.036	1.045
prior_orig 16–20				-0.042	0.034	1.040	-0.006	0.029	1.044
prior_orig 21–25				-0.016	0.031	1.067	-0.032	0.027	1.019
prior_orig 26–30				-0.021	0.031	1.062	-0.029	0.027	1.021
prior_orig 31–50				-0.040	0.027	1.042	-0.015	0.023	1.035
lender 1	0.778***	0.039	1.646	0.780***	0.039	1.646	0.605***	0.034	1.535
lender 2	-0.317***	0.057	0.550	-0.326***	0.057	0.545	-0.819***	0.055	0.370
lender 3	-1.428***	0.075	0.181	-1.428***	0.075	0.181	-0.867***	0.047	0.352
lender 4	-0.187***	0.052	0.627	-0.194***	0.052	0.622	0.258***	0.037	1.086
lender 5	0.472***	0.045	1.212	0.474***	0.045	1.212	-0.031	0.043	0.813
lender 6	-1.770***	0.099	0.129	-1.770***	0.099	0.129	-0.208***	0.041	0.681
lender 7	0.275***	0.054	0.995	0.277***	0.054	0.995	-0.012	0.049	0.829
lender 8	1.068***	0.051	2.199	1.071***	0.051	2.203	0.575***	0.049	1.490
lender 9	-0.081	0.053	0.697	-0.082	0.053	0.695	-0.371***	0.047	0.578
lender 10	0.910***	0.049	1.877	0.915***	0.049	1.884	0.694***	0.043	1.678
Number of observations	65,997			66,238			72,574		

OR = odds ratio. SE = standard error.

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Note: Based on the 2010–11 applications in the Detroit metropolitan area (Macomb, Oakland, and Wayne Counties). Applications that were approved and originated, applications that were denied, and applications that were approved but not accepted by the applicant are included for Model 1 and Model 2. Model 3 further includes applications that were withdrawn by applicants.

Exhibit 4

Logistic Regression Results Based on the 2010–11 Applications in Detroit, With Denial As the Outcome (loan applications as the information variable)

Variable	Model 1 (denial)			Model 2 (denial)			Model 3 (denial/withdrawal)		
	Estimate	SE	OR	Estimate	SE	OR	Estimate	SE	OR
Intercept	-0.551	0.426		-0.098	0.439		0.092	0.375	
pctinc	-0.001***	0.000	0.999	-0.001***	0.000	0.999	-0.001**	0.000	0.999
fha	-0.036***	0.011	0.930	-0.037***	0.012	0.928	-0.040***	0.010	0.924
race (other race)	0.121***	0.028	1.440	0.118***	0.028	1.439	0.141***	0.025	1.424
race (Black)	0.175***	0.032	1.519	0.176***	0.032	1.523	0.130***	0.028	1.410
race (Hispanic)	-0.053	0.054	1.209	-0.048	0.054	1.218	-0.058	0.047	1.168
owner occupied	-0.275***	0.041	0.760	-0.278***	0.041	0.757	-0.245***	0.036	0.783
medinc	-0.001	0.001	0.999	-0.002***	0.001	0.998	-0.001	0.001	0.999
owner_units (in log)	-0.062	0.038	0.940	-0.132***	0.036	0.877	-0.123***	0.030	0.884
rent_to_value	-0.061	0.045	0.941	-0.068	0.045	0.934	-0.053	0.038	0.948
vac_rate	0.011**	0.005	1.011	0.008	0.005	1.008	0.009**	0.005	1.009
pct_black	0.006***	0.001	1.006	0.006***	0.001	1.006	0.006***	0.001	1.006
pct_his	0.007**	0.004	1.007	0.006	0.004	1.006	0.006	0.003	1.006
pct_asian	0.005**	0.002	1.006	0.005**	0.002	1.005	0.004**	0.002	1.004
pct_poverty	0.015***	0.002	1.015	0.013***	0.002	1.013	0.014***	0.002	1.014
pct_owner	0.005***	0.001	1.005	0.005***	0.001	1.005	0.004***	0.001	1.004
tract del rate (high)	0.096***	0.023	1.255	0.103***	0.024	1.267	0.071***	0.020	1.182
tract del rate (med)	0.036**	0.015	1.182	0.031**	0.015	1.179	0.025**	0.013	1.129
fico_score_0508	-0.001	0.000	0.999	-0.001	0.000	0.999	-0.001	0.000	0.999
2010 dummy	0.009	0.012	1.019	0.011	0.012	1.023	0.005	0.010	1.010
Detroit dummy	0.258***	0.085	1.295	0.243***	0.086	1.275	0.208***	0.079	1.231
prior_app (in log)	-0.038	0.023	0.963						
prior_app 0–5				0.443***	0.105	1.603	0.347***	0.098	1.408
prior_app 6–10				-0.062	0.084	0.968	-0.132	0.077	0.872
prior_app 11–15				0.013	0.063	1.043	0.041	0.055	1.037
prior_app 16–20				-0.066	0.055	0.964	-0.031	0.048	0.965
prior_app 21–25				-0.108	0.049	0.925	-0.090**	0.042	0.910
prior_app 26–30				-0.122***	0.044	0.911	-0.088**	0.038	0.911
prior_app 31–50				-0.070**	0.033	0.960	-0.052	0.029	0.945
lender 1	0.780***	0.039	1.645	0.781***	0.039	1.650	0.606***	0.034	1.539
lender 2	-0.327***	0.057	0.544	-0.329***	0.057	0.544	-0.821***	0.055	0.369
lender 3	-1.427***	0.075	0.181	-1.428***	0.075	0.181	-0.868***	0.047	0.353
lender 4	-0.192***	0.052	0.623	-0.188***	0.052	0.626	0.263***	0.037	1.092
lender 5	0.474***	0.045	1.212	0.474***	0.045	1.214	-0.031	0.043	0.814
lender 6	-1.769***	0.099	0.129	-1.769***	0.099	0.129	-0.207***	0.041	0.683
lender 7	0.278***	0.054	0.996	0.276***	0.054	0.996	-0.013	0.049	0.829
lender 8	1.071***	0.051	2.201	1.071***	0.051	2.206	0.575***	0.049	1.492
lender 9	-0.082	0.053	0.695	-0.082	0.053	0.696	-0.373***	0.047	0.579
lender 10	0.914***	0.049	1.882	0.914***	0.049	1.885	0.694***	0.043	1.680
Number of observations	66,199			66,238			72,574		

OR = odds ratio. SE = standard error.

* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Note: Based on the 2010–11 applications in the Detroit metropolitan area (Macomb, Oakland, and Wayne Counties). Applications that were approved and originated, applications that were denied, and applications that were approved but not accepted by the applicant are included for Model 1 and Model 2. Model 3 further includes applications that were withdrawn by applicants.

Exhibit 5

Logistic Regression Results Based on 2010–11 Conventional FHA/VA Loan Applications in Detroit

Variable	Conventional						FHA/VA					
	Model 2 (denial) [N = 30,514]			Model 3 (denial/withdrawal) [N = 33,260]			Model 2 (denial) [N = 35,284]			Model 3 (denial/withdrawal) [N = 38,784]		
	Estimate	SE	OR	Estimate	SE	OR	Estimate	SE	OR	Estimate	SE	OR
Intercept	-0.191	0.682		0.157	0.583		-2.555***	0.705		-1.699***	0.574	
pctinc	-0.002***	0.001	0.998	-0.001***	0.001	0.999	0.000	0.001	1.000	0.000	0.001	1.000
race (other race)	0.090**	0.044	1.448	0.115**	0.038	1.433	0.153***	0.039	1.482	0.180***	0.034	1.476
race (Black)	0.245***	0.059	1.691	0.176***	0.052	1.523	0.145***	0.038	1.471	0.109***	0.034	1.375
race (Hispanic)	-0.054	0.092	1.255	-0.045	0.078	1.221	-0.057	0.067	1.202	-0.080	0.059	1.139
owner occupied	-0.284***	0.043	0.753	-0.252***	0.037	0.777	1.231***	0.334	3.426	0.666***	0.221	1.947
medinc	-0.002	0.001	0.998	-0.001	0.001	0.999	0.001	0.001	1.001	0.001	0.001	1.001
owner_units (in log)	-0.061	0.055	0.940	-0.079*	0.047	0.924	-0.021	0.052	0.979	-0.010	0.045	0.990
rent_to_value	-0.094	0.072	0.910	-0.092	0.061	0.913	-0.025	0.058	0.975	-0.011	0.049	0.989
vac_rate	0.015**	0.008	1.015	0.014**	0.007	1.014	0.006	0.007	1.006	0.008	0.006	1.008
pct_black	0.007***	0.002	1.007	0.007***	0.001	1.007	0.005***	0.001	1.005	0.005***	0.001	1.005
pct_his	0.010	0.006	1.010	0.012**	0.006	1.012	0.005	0.005	1.005	0.004	0.004	1.004
pct_asian	0.002	0.003	1.002	0.002	0.003	1.002	0.009***	0.003	1.009	0.007**	0.003	1.007
pct_poverty	0.013***	0.003	1.013	0.013***	0.003	1.013	0.017***	0.003	1.017	0.016***	0.002	1.016
pct_owner	0.005***	0.002	1.005	0.005***	0.001	1.005	0.003**	0.002	1.003	0.002	0.001	1.002
tract del rate (high)	0.106***	0.037	1.268	0.078***	0.032	1.170	0.083***	0.032	1.196	0.066**	0.027	1.164
tract del rate (med)	0.026	0.022	1.170	0.002	0.019	1.085	0.013	0.022	1.115	0.020	0.019	1.112
fico_score_0508	-0.001	0.001	0.999	-0.001	0.001	0.999	-0.001	0.001	0.999	-0.001	0.001	0.999
2010 dummy	-0.012	0.018	0.976	-0.006	0.015	0.988	0.027*	0.016	1.055	0.011	0.013	1.022
Detroit	0.220	0.156	1.246	0.208	0.146	1.232	0.163	0.112	1.177	0.143	0.101	1.153
prior_orig 0-5	0.375***	0.116	1.708	0.281***	0.108	1.480	0.116	0.088	1.170	0.065	0.079	1.088
prior_orig 6-10	0.069	0.089	1.259	0.059	0.079	1.185	0.019	0.067	1.061	-0.001	0.059	1.019
prior_orig 11-15	-0.031	0.068	1.139	-0.022	0.059	1.093	0.001	0.053	1.042	0.008	0.046	1.028
prior_orig 16-20	-0.057	0.053	1.110	-0.058	0.046	1.054	-0.033	0.044	1.008	0.030	0.038	1.051
prior_orig 21-25	-0.039	0.049	1.130	-0.043	0.042	1.070	-0.017	0.040	1.024	-0.039	0.034	0.982
prior_orig 26-30	-0.069	0.048	1.097	-0.062	0.042	1.050	-0.012	0.041	1.029	-0.022	0.035	0.999
prior_orig 31-50	-0.088	0.041	1.076	-0.045	0.035	1.068	-0.033	0.035	1.007	-0.020	0.031	1.000
lender dummies	included			included			included		included			included

FHA = Federal Housing Administration. OR = odds ratio. SE = standard error. VA = Department of Veterans Affairs.

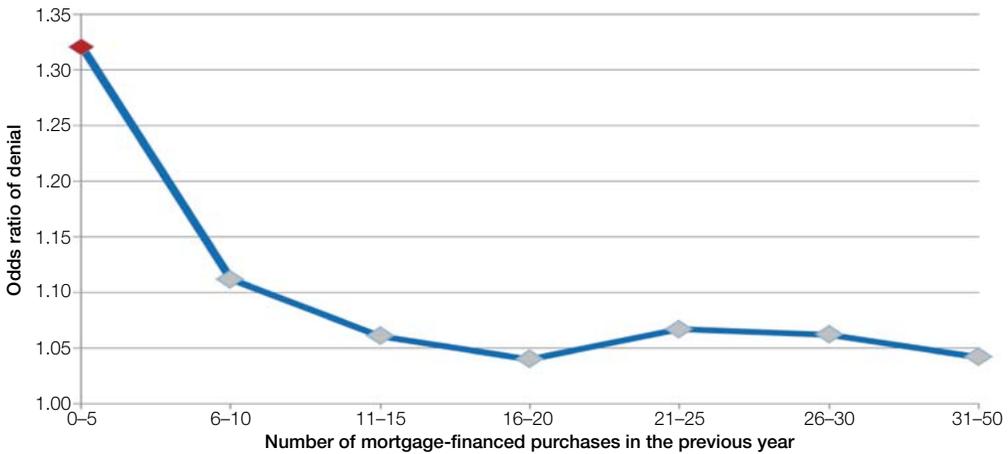
* Significant at the .10 level. ** Significant at the .05 level. *** Significant at the .01 level.

Note: Based on the 2010–11 applications in the Detroit metropolitan area (Macomb, Oakland, and Wayne Counties).

An assessment of the size of the information externality effects is presented in exhibit 6. The odds ratios are based on the specifications of Model 2 in exhibit 3. The graphed numbers measure the odds of denial for different numbers of sales in that tract. The general declining pattern of the plot illustrates the diminishing marginal return to additional mortgage-financed sales as the number of sales increases. The threshold of the effect is about five mortgage purchases in the previous year.

Exhibit 6

The Threshold Effect of Previous Mortgage Purchases



Note: Based on regression results from Model 2 in exhibit 4; odds ratio is only significant for the 5 or fewer purchase mortgages category; the reference group is tracts with more than 50 previous mortgage purchases.

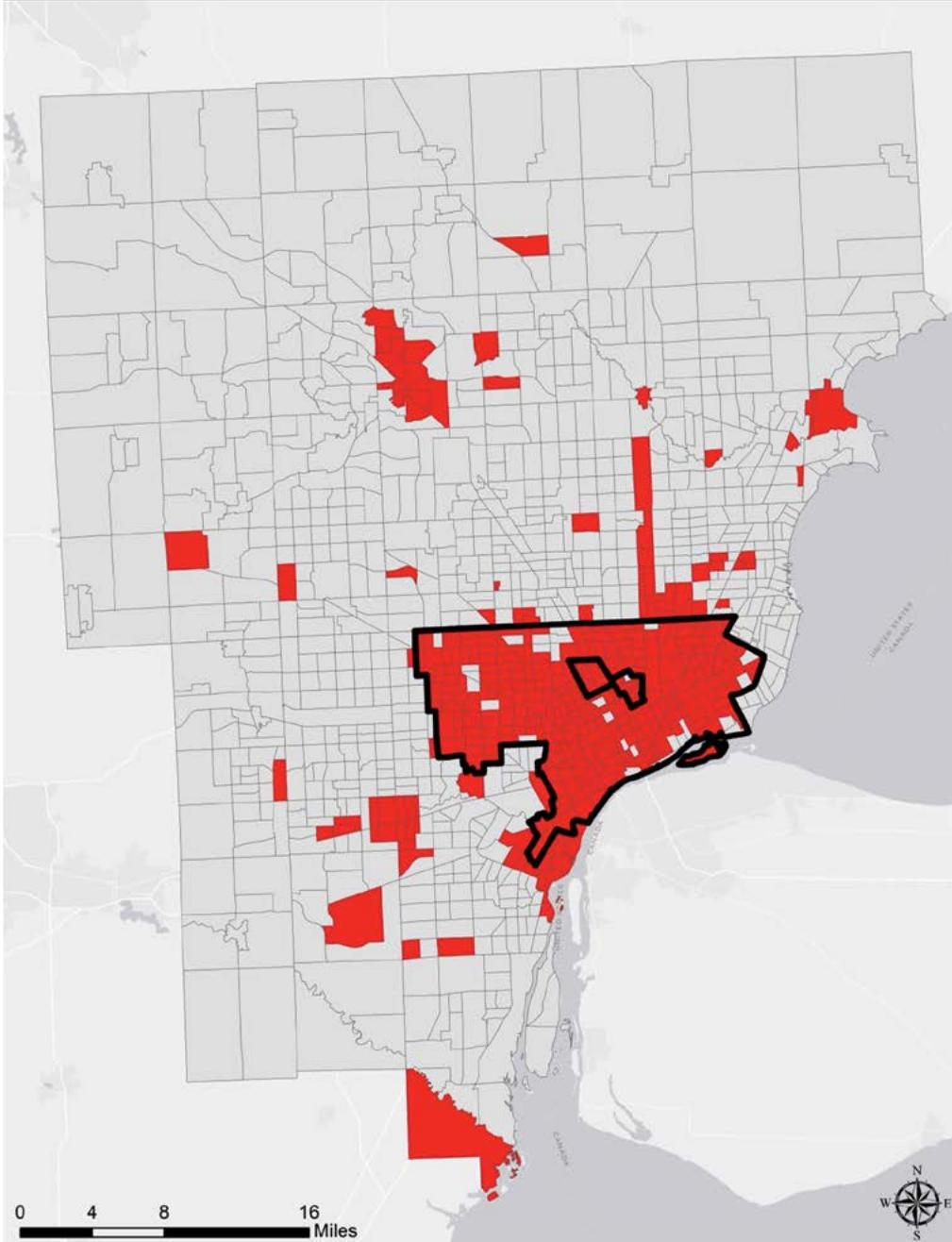
Although the results suggest information externality effects are generally economically unimportant after passing the relatively low threshold (about five loans), in 2010 a total of 345 census tracts in Detroit (or 30 percent of all) had five mortgage originations or fewer. The number of tracts increased to 375 (33 percent of total) in 2011.¹⁶ Exhibit 7 shows these tracts are concentrated in the city of Detroit, along with some neighborhoods outside its border. In the city of Detroit, 96 percent of all tracts had five or fewer purchase mortgage originations in 2011. Given that in the sample more than 30 percent of census tracts (even after excluding those with no mortgage originations even before the housing crisis), had five mortgage-financed purchases or fewer, the results suggest that the lack of previous mortgage originations in a neighborhood is an important obstacle to securing a mortgage for many potential homebuyers in Detroit.

When mortgage application denial or withdrawal is used as the dependent variable in the model, the results are quite consistent: when the number of previous mortgage purchases is five or fewer, the odds of application denial or withdrawal increase 19.4 percent. Of course, HMDA data do not provide information about the reasons for application withdrawals; insufficient appraisal value

¹⁶ A total of 29 tracts zoned for industrial or commercial uses, such as airports, shopping malls, industry, agricultural use, or no market activities, even before the housing crisis (in 2007), were excluded from the total. No residential mortgage originations are expected in these neighborhoods.

Exhibit 7

Census Tracts With Five or Fewer Mortgage Purchases in 2011 (Detroit metropolitan area)



Notes: Tracts in red represent neighborhoods with five or fewer purchase loan originations in 2011. The bold black lines show the boundary of the city of Detroit.

Source: Home Mortgage Disclosure Act.

could be only one of many reasons. So the link between prior lending and application withdrawal is not so straightforward. The results similarly suggest a positive effect of prior mortgage applications on the denial (and withdrawal) decision (when the number of applications is five or fewer) (exhibit 4), but the number of mortgage applications (in log) is insignificant in predicting the loan decision, which needs additional future investigation.

Furthermore, would information externality be less of a problem for government-guaranteed (FHA and VA; hereafter, for simplification, FHA) loan applications or would appraisal uncertainty be a bigger problem because these loans tend to have high LTV ratios? The results seem to support the former contention. The results suggest that there is statistical support that FHA loan applications generally have a lower probability of denial, relative to conventional loan applications. Results from separate regressions of conventional and FHA loan applications indicate that the number of mortgage originations (either in log or in categories) is insignificant for FHA loans (exhibit 5). By contrast, the results suggest the same level of threshold (five or fewer mortgage originations) for conventional mortgage originations. In practice, FHA appraisal even adds additional requirements over a conventional appraisal to reduce the risk of major repairs that may be needed during the short term. FHA allows for a much higher LTV ratio, however, than that of conventional government-sponsored enterprise (GSE) loans (when they do not have private mortgage insurance), which should provide a greater cushion when appraisals are low. In addition, FHA lenders are usually specialized lenders with larger market share, and likely more local knowledge, in the many hard-hit neighborhoods. All these factors may help explain the result that information externality is a less serious problem for FHA lending in Detroit.

The neighborhood mortgage default rates also have a positive relationship with the likelihood of denial, which is consistent with expectation. If the property is in a neighborhood with a very high default rate (higher than 17 percent), the odds of denial are 26 percent higher. If the property is in a neighborhood with a relatively high default rate (14 to 17 percent), the odds of denial are 16 percent higher. Neighborhood mortgage default rates may capture some unobserved risk of the borrowers and properties in the neighborhood. In addition, lenders may have taken the unobservable information into consideration during underwriting. Furthermore, higher neighborhood default rates will likely lead to a higher share of distressed home sales, which may bias appraisals. This increased appraisal bias will also increase the likelihood that a mortgage application is denied.

Several neighborhood-level characteristics are significant in these specifications, such as the percentage of minorities (Black or Hispanic) and the neighborhood vacancy rate. As the percentage of minorities in a neighborhood increases, the probability of denial increases, which is consistent with most early studies on the redlining issue.¹⁷ The city dummy is significant at the 0.05 level and associated with a higher probability of denial because of observable risk characteristics. The dummies for individual lenders are generally significant, which supports the proposition of the difference in mortgage-lending underwriting policies across banks. The coefficient for Hispanic borrowers is insignificant, although the coefficients for Black borrowers and borrowers with missing information on race information are significant and positive.

¹⁷ Few exceptions exist. For example, Blackburn and Vermilyea (2007) found mild statistical support for an increase in the percentage of minorities being associated with increased loan acceptance rates.

Conclusion

This empirical study focuses on the effect of information externality provided by prior transactions on lending decisions in Detroit, an extremely hard-hit housing market during the housing crisis. The results of the analysis suggest that the lack of mortgage-financed home sales in a neighborhood has become a serious challenge for the access to credit for future applicants and the recovery of the housing market in many neighborhoods in Detroit.

The results show that significant information effects exist in the Detroit housing market. The significant effect is primarily relevant in the conventional mortgage market and the effect has a relatively low threshold: when the number of purchase loan originations is five or fewer in the previous year, the odds of denial increase 32 percent. More than 30 percent of all neighborhoods in Detroit, including nearly all neighborhoods in the city of Detroit, have been adversely affected by the lack of reliable information on neighborhood home sales prices during the study period. The results also provide evidence that foreclosures and distressed home sales are important to estimating the effect of information externalities.

Results from this case study of Detroit help us understand how information externalities from previous transactions affected the loan decision outcome following the recent housing crisis. Information externalities may be viewed as a market imperfection in which potential borrowers may be able to obtain financing in high-activity areas but are unable to do so for an equivalent transaction in a lower activity neighborhood. The existence of such externalities may provide justification for narrowly tailored intervention programs in the hardest hit areas by the public or philanthropic originations. If well-targeted programs are designed to mitigate the effects of information externalities, they should provide a better understanding of market values, stimulate the flow of credit to economically disadvantaged neighborhoods, and stabilize the housing markets in distressed areas. Another strategy is to encourage greater information sharing among lenders for mortgage applications, or to have public or philanthropic organizations help people secure a mortgage with the most likely lenders. The significant effect that foreclosures have on property values also suggests, although not conclusively, that to attain more accurate estimates of the true values of properties for sale, GSEs and the FHA should exercise caution when accepting distressed home sales as valid comparable properties.

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Author

Lei Ding is a community development economic advisor at the Federal Reserve Bank of Philadelphia.

References

- Appraisal Institute. 2008. "Making Sense of the Nonsense: Providing Credible Appraisals in a Declining Market." Available at http://www.appraisalinstitute.org/about/downloads/Distressed_Sales.pdf (accessed February 24, 2014).
- Avery, Robert B., Patricia E. Beeson, and Mark S. Sniderman. 1999. "Neighborhood Information and Home Mortgage Lending," *Journal of Urban Economics* 45: 287–310.
- Berkovec, James, Glenn Canner, Stuart Gabriel, and Timothy Hannan. 1998. "Discrimination, Competition, and Loan Performance in FHA Mortgage Lending," *The Review of Economics and Statistics* 80 (2): 241–250.
- Blackburn, McKinley, and Todd Vermilyea. 2007. "The Role of Information Externalities and Scale Economies in Home Mortgage Lending Decisions," *Journal of Urban Economics* 61 (1): 71–85.
- Calem, Paul S. 1996. "Mortgage Credit Availability in Low- and Moderate-Income Minority Neighborhoods: Are Information Externalities Critical?" *Journal of Real Estate Finance and Economics* 13: 71–89.
- Calem, Paul S., Kevin Gillen, and Susan M. Wachter. 2004. "The Neighborhood Distribution of Subprime Mortgage Lending," *Journal of Real Estate Finance and Economics* 29 (4): 393–410.
- . 1999. "Community Reinvestment and Credit Risk: Evidence From an Affordable-Home-Loan Program," *Real Estate Economics* 27 (1): 105–134.
- Campbell, John Y., Stefano Giglio, and Parag Pathak. 2011. "Forced Sales and Housing Prices," *American Economic Review* 101 (5): 2108–2131.
- Cho, Man, and Isaac F. Megbolugbe. 1996. "An Empirical Analysis of Property Appraisal and Mortgage Redlining," *Journal of Real Estate Finance and Economics* 13 (1): 45–55.
- Ding, Lei, Roberto G. Quercia, Wei Li, and Janneke Ratcliffe. 2011. "Risky Borrower or Risky Mortgages: Disaggregating Effects Using Propensity Score Models," *Journal of Real Estate Research* 33 (2): 245–277.
- Ding, Lei, Janneke Ratcliffe, Michael A. Stegman, and Roberto G. Quercia. 2008. "The Neighborhood Patterns of Higher Priced Lending: The Case of Atlanta," *Journal of Affordable Housing and Community Development Law* 17 (3): 193–217.
- Forgey, Fred A., Ronald C. Rutherford, and Michael L. VanBuskirk. 1994. "Effect of Foreclosure Status on Residential Selling Price," *Journal of Real Estate Research* 9 (3): 313–318.
- Foster, Chester, and Robert Van Order. 1984. "An Option-Based Model of Mortgage Default," *Housing Finance Review* 3 (4): 351–372.
- Galster, George C. 2012. "The Mechanism(s) of Neighbourhood Effects: Theory, Evidence, and Policy Implications." In *Neighbourhood Effect Research: New Perspectives*, edited by Maarten van Ham, David Manley, Nick Bailey, Ludi Simpson, and Duncan Maclennan. Dordrecht, The Netherlands: Springer: 23–56.

- Hardin, William G., and Marvin L. Wolverton. 1996. "The Relationship Between Foreclosure Status and Apartment Price," *Journal of Real Estate Research* 12 (1): 101–109.
- Harrison, David M. 2001. "The Importance of Lender Heterogeneity in Mortgage Lending," *Journal of Urban Economics* 49: 285–309.
- Hutto, Gary. 2003. *Handbook of Mortgage Lending*. Washington, DC: Mortgage Bankers Association of America.
- Immergluck, Dan, and Geoff Smith. 2006. "The External Costs of Foreclosure: The Impact of Single-Family Mortgage Foreclosures on Property Values," *Housing Policy Debate* 17 (1): 57–79.
- LaCour-Little, Michael, and Richard Green. 1998. "Are Minorities or Minority Neighborhoods More Likely To Get Low Appraisals?" *Journal of Real Estate Finance and Economics* 16 (3): 301–315.
- LaCour-Little, Michael, and Stephen Malpezzi. 2003. "Appraisal Quality and Residential Mortgage Default: Evidence From Alaska," *Journal of Real Estate Finance and Economics* 27 (2): 211–233.
- Ladd, Helen F. 1998. "Evidence on Discrimination in Mortgage Lending," *The Journal of Economic Perspectives* 12 (2): 41–62.
- Lang, William M., and Leonard I. Nakamura. 1993. "A Model of Redlining," *Journal of Urban Economics* 33 (2): 223–234.
- Leventis, Andrew. 2006. Removing Appraisal Bias From a Repeat-Transactions House Price Index: A Basic Approach. OFHEO working paper. Available at http://www.fhfa.gov/webfiles/1271/061appraisal_bias.pdf (accessed February 24, 2014).
- Lin, Zhenguang, Eric Rosenblatt, and Vincent Yao. 2009. "Spillover Effects of Foreclosures on Neighborhood Property Values," *Journal of Real Estate Finance and Economics* 38 (4): 387–407.
- Ling, David C., and Susan M. Wachter. 1998. "Information Externalities and Home Mortgage Underwriting," *Journal of Urban Economics* 44 (3): 317–332.
- Munnell, Alicia H., Geoffrey M. B. Tootell, Lynn E. Browne, and James McEneaney. 1996. "Mortgage Lending in Boston: Interpreting HMDA Data," *American Economic Review* 86 (1): 25–53.
- Murphy, Edward V. 2012. "Regulation of Real Estate Appraisers." Congressional Research Service. Available at <http://www.fas.org/sgp/crs/misc/RS22953.pdf> (accessed February 24, 2014).
- Nakamura, Leonard I. 2010. "How Much Is That Home Really Worth? Appraisal Bias and House-Price Uncertainty," *Federal Reserve Bank of Philadelphia Business Review* First Quarter: 11–22.
- Pennington-Cross, Anthony, and Giang Ho. 2010. "The Termination of Subprime Hybrid and Fixed-Rate Mortgages," *Real Estate Economics* 38 (3): 399–426.
- Quercia, Roberto G., and George C. Galster. 2000. "Threshold Effects and Neighborhood Change," *Journal of Planning Education and Research* 20 (2): 146–163.
- Quercia, Roberto G., and Michael Stegman. 1992. "Residential Mortgage Default: A Review of the Literature," *Journal of Housing Research* 3 (2): 341–379.

- Ross, Stephen, and John Yinger. 2002. *The Color of Credit: Mortgage Discrimination, Research Methodology, and Fair-Lending Enforcement*. Cambridge, MA: MIT Press.
- Schill, Michael, and Susan M. Wachter. 1993. "A Tale of Two Cities: Racial and Ethnic Geographic Disparities in Home Mortgage Lending in Boston and Philadelphia," *Journal of Housing Research* 4 (2): 245–275.
- Schuetz, Jenny, Vicki Been, and Ingrid G. Ellen. 2008. "Neighborhood Effects of Concentrated Mortgage Foreclosures," *Journal of Housing Economics* 17 (4): 306–319.
- Southeast Michigan Council of Governments (SEMCOG). 2012. *Key Regional Housing Issues: Developing a Regional Housing Action Agenda for Southeast Michigan Report*. Regional Housing Strategy Task Force, January 26, 2012.
- Steinke, William G. 2012. "Price, Value, and Comparable Distinctions in Distressed Markets," *Appraisal Journal* 80 (2): 140.
- Tootell, Geoffrey M.B. 1996. "Redlining in Boston: Do Mortgage Lenders Discriminate Against Neighborhoods?" *Quarterly Journal of Economics* 111 (4): 1049–1079.
- Vandell, Kerry D. 1995. "How Ruthless Is Mortgage Default? A Review and Synthesis of the Evidence," *Journal of Housing Research* 6 (2): 245–262.