Spillover Effects of Subprime Mortgage Originations:*

The Effects of Single-family Mortgage Credit Expansion on the Multifamily Rental Market

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ABSTRACT

The dramatic expansion in subprime mortgage credit fueled a remarkable boom and bust in the US housing market and created a global financial crisis. Even though considerable research examines the housing and mortgage markets during the previous decade, how the expansion in mortgage credit affected the rental market remains unclear; and yet, over 30 percent of all U.S. households reside in the rental market. Our study fills this gap by showing how the multifamily rental market was adversely affected by the development of subprime lending in the single-family market before the advent of the 2007/2008 subprime induced financial crisis. We provide evidence for a fundamentals based linkage by which the effect of an innovation in one market (i.e, the growth in subprime mortgage originations) is propagated through to another market. Using a large database of residential rental lease payment records, our results confirm that the expansion in subprime lending corresponds with an overall decline in the quality of rental payments. Finally, we present evidence showing that the financial performance of multifamily rental properties reflected the increase in rental lease defaults.

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PRELIMINARY: PLEASE DO NOT QUOTE

1 Introduction

The United States of America experienced a remarkable housing boom and bust during the previous decade that spawned a global financial crisis in 2007 and 2008. Due to the profound, lasting and wide-ranging effects of this crisis, economists have focused considerable attention on the crisis' causes and their possible spillovers to other sectors. As a result, many theories exist that attempt to explain the growth in homeownership and mortgage credit. For example, Glaeser (2010) ties the seeds of the housing boom and bust to policies that created direct and indirect subsidies designed to promote homeownership. Other studies have suggested that the housing boom resulted from interest rate policies that were pursued by the Federal Reserve in an effort to stimulate the economy following the dot-com recession in 2001 as well as from foreign capital being invested in U.S. mortgage-backed securities.[1] The majority of research on the causes and consequences of the housing and financial crisis focuses attention on the relation between homeownership policies and mortgage markets. Thus, even though considerable research examines the housing and mortgage markets during the previous decade, how the expansion in mortgage credit affected the rental market remains unclear; and yet, over 30 percent of all U.S. households reside in the rental market.[2] Our study fills this gap by showing how the residential rental market was adversely affected by the development of subprime lending long before the advent of the 2007/2008 subprime induced financial crisis.

The support for homeownership policies and subsidies is often justified by citing numerous benefits or externalities conferred upon society by homeowners. For example, DiPasquale and Glaeser (1999) demonstrate that homeownership creates positive "social capital" by encouraging higher voter turnout while Glaeser and Shapiro (2003) note that homeownership

[1]For example, the *Financial Crisis Inquiry Commission Report* (2011) provides evidence linking Federal Reserve interest rate policies between 2001 and 2003 with the goal of supporting the housing market. In addition, the report documents that mortgage credit expanded in part due to purchases by foreign banks and funds of U.S. mortgage-back securities.

[2]According to the Joint Center for Housing Studies (2013), 31 percent of households in 2004 resided in the rental market. Following the financial crisis, fully 35 percent, or 43 million households resided in the rental market by the end of 2012.

creates barriers to mobility that fosters greater civic participation. However, recent evidence by Engelhardt et al. (2010) casts doubt on the role of homeownership in promoting civic involvement. Other studies have linked owner occupied housing to positive benefits for children (Haurin, Parcel, and Haurin, 2002; and Green and White, 1997) and greater investment in maintenance and upkeep of the housing stock (Galster, 1983; and DiPasquale and Glaeser, 1999.) Furthermore, Coulson, Hwang, and Imai (2001) and Glaeser and Shapiro (2003) document that increases in local homeownership rates are tied to substantial increases in housing values. More recently, Coulson and Li (2013) build on this literature to document that the transition from renting to owner-occupied status produces approximately $1,300 per year in external benefit in a typical neighborhood.

While the benefits of homeownership are widely acknowledged, the costs associated with policies designed to promote the housing market and homeownership can be substantial. For example, numerous studies have focused on the direct costs arising from the mortgage interest deduction (MID) as well as the implicit costs associated with overconsumption of housing that results from the MID subsidy.[3] In addition, Glaeser (2010) notes that homeownership subsidies related to the mortgage market provide little or no benefit to lower income families that tend to be renters. Furthermore, Ambrose and Goetzmann (1998) and Goetzmann and Spiegel (2002) examine the "investment" aspect of homeownership and conclude that policies promoting greater homeownership may inadvertently lead households to significant under diversified investment portfolios.

We expand on these studies of homeownership externalities by focusing on the impact that growth in mortgage credit, and by extension, growth in the homeownership rate, during the housing boom of the previous decade had on the risk of the rental housing sector. In particular, we examine how subprime lending created ripple effects across the residential rental market. Our results demonstrate how the expansion in mortgage credit altered the

[3]See Arron (1972), Rosen (1979, 1985), Poterba (1984, 1992), Mills (1987), Glaeser and Shaprio (2003), and Poterba and Sinai (2008). Glaeser (2010) also points out that policies designed to promote homeownership tend to encourage excessive investment in housing and by extension, increases urban sprawl.

underlying risk profile of the rental population, which in turn increased rents. Thus, our analysis illustrates the importance of considering second order effects when evaluating public policies.

To place our study in context, we note that the housing boom and bust of the previous decade arose from a number of features that provide the ability to examine how changes in one market may impact other related markets. For example, Chomsisengphet and Pennington-Cross (2006), Mayer and Pence (2008), Danis and Pennington-Cross (2008), Greenspan and Kennedy (2008), Demyanyk and Van Hemert (2009), Longstaff (2010), Gorton (2010), and many others, have documented how the 2007/2008 financial crisis began as a result of rising defaults among U.S. subprime mortgages, implying a connection between a small sector of the mortgage market and the broader financial system. In other areas, economists have demonstrated that the expansion in mortgage credit though securitization and growth in subprime lending contributed to the housing price boom (Mian and Sufi, 2009), reduced the incentives to screen borrowers (Keys, et al., 2010; Agarwal, Chang and Yavas, 2012; and Greenspan, 2010), and created incentives for borrowers to misrepresent asset values (Ben-David, 2011). Thus, while many studies have focused on the spillover effects of subprime lending to other areas of the housing and mortgage markets (i.e. house price growth, foreclosure and loss mitigation, appraisal, etc.), the fundamental spillover effects of subprime mortgage origination activity on other markets remains unclear.

To illustrate the connection between subprime mortgage credit expansion and residential rental risk, Figure 1 displays the basic default hazard curves for a random sample of multifamily leases distributed between 2001 and 2006 in markets that experienced low and high subprime activity.[4] As expected, the hazard curves show a steep increase in defaults during the first months, reaching a maximum at around month five, and a slower downward

[4]Section 3 describes the lease data in greater detail. We classified MSAs covered by RentBureau into quartile groups according to the percentage of purchase subprime mortgage originations from 2001 to 2006. MSAs in the bottom (top) quartile are classified as low (high) subprime areas. We then drew a random sample of 27,500 leases from the MSAs in the top and bottom quartiles. Table 1 reports the estimated coefficients for the simple Cox (1072) proportional hazard models that produced the hazard curves in Figure 1 where a lease default is defined as the first occurrence of a missed rent payment.

trend as leases are removed from the sample after the first default event is observed. As noted in Table 1, the insignificant coefficient for *SUBPRIME*, the subprime dummy identifying high-subprime MSAs, for the years 2002 and 2003 indicates no difference in the lease default hazard curves between the low and high subprime MSA. However, for years 2004 through 2006, both Figure 1 and Table 1 show statistically higher incidences of lease defaults in the high-subprime MSAs.[5] In addition, the evolution of hazard curves in the high subprime MSAs (Figure 2) shows a pattern of increasing lease defaults coinciding with the growth in subprime lending.[6]

Our formal analysis rests on the fundamental decision households make regarding housing consumption, the decision to rent or own. The housing tenure choice literature views owning and renting as substitutes, with household characteristics and financial considerations playing an important role in housing demand and tenure choice decisions (Henderson and Ioannides, 1983; Ioannides and Rosenthal, 1994). Since most households typically borrow the bulk of the purchase price of their home, the availability of mortgage financing influences these decisions as well.[7] Thus, the sustained growth in mortgage lending from 2001 to 2006, attributed in part to the interaction of looser underwriting standards and the development of innovative mortgage products targeted at under-served populations (Kiff and Mills, 2007; Watcher, Pavlos and Pozar, 2008), enabled numerous households previously excluded from the mortgage market to achieve, at least temporarily, the American dream of homeownership (Bernanke, 2007). As a result, the national average homeownership rate grew 2.4% from 67.5% in 2000 to 68.9% in 2006 (Figure 3). This phenomenon was more pronounced in

[5] The lease default rates were 31%, 44%, and 28% higher in the high-subprime MSAs compared to the low-subprime MSAs in 2004, 2005, and 2006, respectively.

[6] The crossing of hazard curves after month 12 reflects the fact that most residential leases are for 12 months initially and are renewed only if the building manager is satisfied with the renter's performance. Since not all leases are renewed at expiration, the appropriate observation period for this analysis is 12 months.

[7] For example, Linneman and Wachter (1989), Duca and Rosenthal (1994), Haurin, Hendershott, and Watcher (1997), and Linneman, Megbolugbe, Watcher, and Cho (1997) among others show that borrowing constraints, both wealth and income related, limit households' propensities to become homeowners. More recently, Calem, Firestone, and Wachter (2010) also emphasize the primary adverse effects of credit impairment and lack of credit history on homeownership.

urban areas where average homeownership rates in metropolitan areas and major cities rose by 2.9% and 5.6%, respectively.

However, while the homeownership rate was increasing, the risk profile for the population of renters also changed. For example, Figure 3 also shows the deterioration in median household income earned by renters as compared to the national median household income during the period covered by this study.[8] Consistent with the notion that the characteristics of the renter population shifted during the housing bubble, we see that the median renter household income as a percentage of all household median income declined from 67.5% in 2001 to 62.7% by 2005, indicating a significant shift in the income level of the renter population. As our analysis shows, this increase in the risk profile of the rental population is consistent with the notion that expansion in mortgage credit through subprime lending altered the underlying risk distribution of the rental population.

Given the remarkable expansion of mortgage credit in the previous decade, a natural question then is to what extent did the growth in homeownership adversely affect the residential rental market. We address this question by examining the performance of residential leases using a national database of multifamily rental data. We analyze the probability of lease payment defaults during the period of explosive growth in subprime lending. After controlling for the effects of other potential determinants of lease defaults as well as the potential endogenous relation between area risk and subprime mortgage activity, we rely on the preponderance of the evidence to conclude that a significant (both economically and statistically) positive relation exists between subprime lending and the likelihood of lease defaults. Our results indicate that a 1% increase in an area's subprime activity corresponds to a 1.9% increase in the area's lease default index. We also show that the increase in lease defaults resulted from the migration of low risk renters into homeownership. As a result of this shift in the underlying risk profile of the renter population that lead to higher rental default rates and losses, we provide evidence suggesting that areas which experienced higher

[8]Collison (2011) presents a detailed analysis of the rental market dynamics at both the national and metropolitan levels during that period.

rental default rates subsequently experienced higher rent rates. Furthermore and consistent with a subprime spillover across fundamental property markets, we document a simultaneous deterioration in the performance of multifamily properties. For example, our analysis indicates that a 1% increase in rental defaults results in a 0.16% decrease in the average annual income component of the property return. Finally, we also document a positive and significant relation between rental default rates and multifamily property capitalization rates; verifying that an increase in overall rental contract defaults results in a decline in multifamily property values and thus confirms the fundamental spillover mechanism whereby subprime origination activity affected multifamily asset values. Our analysis demonstrates that subprime lending allowed lower risk renters to migrate into homeownership, leaving behind a riskier renter population. Thus, we provide evidence for a fundamentals based linkage by which an event from one market (i.e, the growth in subprime mortgage originations) is propagated through to another market creating a mechanism for a spillover effect. To our knowledge, this is the first study of the adverse effect of the recent mortgage expansion and housing bubble on the residential rental market.

Our paper proceeds as follows. Section 2 presents a simple model of rental risk that motivates the empirical analysis. Section 3 describes the dataset. We then proceed with a formal empirical analysis in section 4 and section 5 extends the analysis to look at rental losses. Section 6 examines the connection between rental defaults and rent while section 7 provides preliminary evidence of the impact of the deterioration in residential renter credit risk on property performance. Finally, section 8 concludes by summarizing the key points of this study and introduces potential research questions.

2 A Simple Model of Rental Risk

Our goal in this section is to present a simple model illustrating how changes in the mortgage market and underlying economic conditions could impact the rental market risk distribution.

Our model captures two stylized facts observed during the previous decade. First, following the 2001 recession overall household credit risk declined as the economy expanded. For example, Figure 4 shows that the U.S. average unemployment rate steadily declined from 2003 through 2007 as the economy recovered from the 2001 recession. Second, as home prices increased mortgage credit supply, and subprime mortgage credit in particular, expanded through the relaxation of underwriting standards. Figure 5 shows the relaxation in bank lending standards over this period as reported by the Federal Reserve Board's Bank Officer Survey.[9] Furthermore, recent studies by Glaeser, Gottlieb and Gyourko (2010), Coleman, LaCour-Little and Vandell (2008), Mian and Sufi (2009), and Anderson, Capozza and Van Order (2008) document a significant expansion in subprime lending in the last decade along with a deterioration in standard underwriting metrics.

In order to isolate the impact of tenant credit risk, we simplify the analysis by assuming that households have a strict preference for ownership over tenancy for housing units that provide identical utility. Hendersen and Ioannides (1983), Ioannides and Rosenthal (1994), Calem et al. (2010), and Duca and Rosenthal (1994) provide evidence showing that tenure choice decisions depend on household characteristics and financial position, as well as capital market conditions, and that some households may find renting optimal. Assuming that the risk distribution of these optimal renters is constant over time, variations in the riskiness of the renter population will be mainly driven by credit availability. Thus, this assumption allows us to study the implications of changes in the mortgage market on the overall credit risk of renter households.

We begin by modeling the distribution of home owners and renters in a spatially defined, local market using the approach of Ferguson and Peters (1995) and Ambrose, Pennington-Cross, and Yezer (2002). We assume that all information about a household's ability to obtain mortgage credit is quantified by an inverse credit risk score (Φ) that is a monotonically increasing function of household's probability of default. Furthermore, we assume that

[9] http://research.stlouisfed.org/fred2/series/DRTSCLCC

all lenders set minimum underwriting standards (Φ^*) such that households with credit risk scores above this score are rejected and all households with credit scores below receive mortgages. Thus, households that are rejected by lenders are confined to the rental market. We define $r(\Phi)$ as the marginal probability density function and $R(\Phi)$ as the cumulative density function of the household's credit risk.

In order to show the effects of the expansion in subprime lending, we segment the mortgage market into conventional and subprime lenders with corresponding underwriting standards of Φ^C and Φ^S, respectively. The probability that a household applies for a conventional or subprime mortgage is a function of both the household's credit risk and the prevailing underwriting standards. Following Ambrose, Pennington-Cross, and Yezer (2002), we assume that $\alpha(\Phi; \Phi^C)$ is the share of households with credit risk Φ that apply for subprime mortgages given conventional underwriting standards (Φ^C). We note that $\alpha(\Phi; \Phi^C)$ is an increasing function of Φ, is approximately 0 when $\Phi \ll \Phi^C$ and increases monotonically to 1 at some value of $\Phi > \Phi^C$.

Figure 6 shows the distribution of household tenure status based on the marginal density function of credit risk and underwriting standards. Consistent with the subprime market being less than 20 percent of all mortgage origination activity, we show the conventional underwriting criteria (Φ^C) to the right of the peak of the distribution and the subprime underwriting criteria (Φ^S) to the right of Φ^C.[10] Let $A(\Phi^C)$ denote the fraction of households that apply for a subprime mortgage such that

$$A(\Phi^C) = \int_0^1 r(\Phi)\alpha(\Phi; \Phi^C) d\Phi. \tag{1}$$

Thus, in Figure 6 the value of $A(\Phi^C)$ is given as the region $Y + Z + M$. The fraction of all

[10] See Chomsisengphet and Pennington-Cross (2006) for a description of the development of the subprime market that confirms this assumption.

households that apply for a subprime mortgage and are accepted is denoted as:

$$E(\Phi^C; \Phi^S) = \int_0^{\Phi^S} r(\Phi)\alpha(\Phi; \Phi^C)d\Phi \tag{2}$$

and is represented as $Y + Z$. Finally, the fraction of households that are rejected by subprime lenders is

$$D(\Phi^C; \Phi^S) = \int_{\Phi^S}^{1} r(\Phi)\alpha(\Phi; \Phi^C)d\Phi \tag{3}$$

and is represented by region M. Similar relations can be shown based on the conventional underwriting criteria (Φ^C) with region N in Figure 6 denoting the fraction of households that are rejected from conventional lenders but do not find subprime financing attractive or do not apply for such financing. Thus, the combination of areas N and M represents the rental market. Since households in region N are of lower risk than households in region M, the overall risk of the rental market will depend on the relative sizes of regions N and M.

As discussed above, we are interested in determining the effect of two changes observed during the recent U.S. housing bubble period: a decrease in overall household credit risk and a decline in subprime mortgage underwriting standards. First, Figure 7 illustrates the effects of a decrease in household credit risk holding mortgage underwriting standards constant. We show the impact on the owner and renter market by the leftward shift in the distribution of household credit risk from $r(\Phi)$ to $r'(\Phi)$ such that $R'(\Phi) > R(\Phi)\ \forall\ \Phi$.[11] As Φ^C and Φ^S remain fixed and $r(\Phi)$ shifts to $r'(\Phi)$ where $r(\Phi)$ first order stochastically dominates $r'(\Phi)$, then $r(\Phi)\alpha(\Phi; \Phi^C)$ rotates downward to $r'(\Phi)\alpha(\Phi; \Phi^C)$ represented by the solid line. As a result, the number of households originating conventional mortgages increases ($X' > X$) while the fraction of households originating subprime mortgages declines ($Y' + Z' < Y + Z$). Although the number of subprime rejections decreases ($M' < M$), it is not clear how the fraction of households remaining in the rental market is affected since N' is not necessarily

[11]Following Ferguson and Peters (1995), the shift in the credit risk distribution implies that $R(\Phi)$ first order stochastically dominates (FOSD) $R'(\Phi)$.

smaller than N. As noted above, area N shrinks due to the leftward shift in $r(\Phi)$ but expands as a result of the downward rotation in $r(\Phi)\alpha(\Phi;\Phi^C)$ to $r'(\Phi)\alpha(\Phi;\Phi^C)$. However, during the housing bubble $\alpha(\Phi;\Phi^C)$ increased over time as subprime borrowing gained acceptance with the public and subprime premiums over conventional mortgage rates declined.[12] Thus, this upward movement in $\alpha(\Phi;\Phi^C)$ had the effect of reducing the degree of downward rotation caused by the shift from $r(\Phi)$ to $r'(\Phi)$ that would have occurred if $\alpha(\Phi;\Phi^C)$ remained constant. Therefore, it is an open empirical question as to what was the net effect on the size of the low-risk renter population.

The second change to the mortgage market during the housing bubble period was that mortgage underwriting standards, and subprime underwriting standards in particular, declined suggesting that Φ^S shifted to the right to $\Phi^{S'}$. Figure 8 shows the effect of this shift combined with the reduction in household credit risk. As noted above, the decrease in household credit risk as the economy expands increases the number of households who qualify for conventional mortgages thereby reducing the number of households who remain in the rental market. In addition, as subprime underwriting criteria decline, the number of households who qualify for subprime mortgage credit increases, further reducing the size of the rental market who do not qualify for mortgage financing from M' to M'' (N' remaining unchanged).

Although both the economic recovery and the relaxation of subprime underwriting standards reduce the number of subprime rejections ($M'' < M$) over time, they have opposite effects on the average riskiness of that renter group. However, the overall effect on the riskiness of the whole renter population depends on the size of area N' relative to M'' as compared to N relative to M. As noted above, it is unclear whether the combination of the economic recovery and the decrease in mortgage origination standards had an effect on the size of area N. The net effect on area N depends on the relative magnitude of these two events. Consequently, the combined effect of the economic recovery and the subprime

[12]See Chomsisengphet and Pennington-Cross (2006) and Demyanyk and Hemert (2009) for evidence showing an overall decline in subprime interest rate premiums.

expansion becomes an empirical question.

Although the impact of the expansion of the subprime market on the risk of the rental market is ultimately an empirical question, we believe an overall increase of the average credit risk of the rental market to be more likely. We conjecture that the substantial growth in subprime lending during that period, which is likely to overwhelm the positive impact of the economic recovery, combined with the gain in acceptability of subprime borrowing amongst households with relatively good credit resulted in area N' becoming relatively smaller as compared to N and M. To the extent that the number of households who do not qualify for any mortgage credit remains larger than the number of lower risk renters ($N' < M''$) and the credit constrained renter group becomes riskier (M'' riskier than M), then the overall observed riskiness of the rental population should increase. In other words, if the expansion of the subprime market pulls a greater proportion of lower risk renters into homeownership, then the overall riskiness of the remaining rental population should increase. We empirically test if this was effectively the case by examining cross sectional differences in rental population default rates, controlling for changes in subprime mortgage origination activity.

3 Residential Lease Data

To measure changes in the overall risk in the rental market, we utilize the residential rent data compiled by Experian RentBureau for the period from January 2002 to November 2009. RentBureau maintains a national database collected from property management companies consisting of hundreds of thousands of individual lease contracts originated during this period from approximately 2,000 multifamily properties (complexes). The database contains lease characteristics (lease start date, lease termination date, renter move-in date, renter move-out date, last transaction date) and property location (city, state, and zip-code). To maintain privacy, limited information is disclosed on specific property locations and individual renters. The company updates lease records every month, noting whether rent was paid on time or not, the type of payment delinquency, if applicable, the accrued number of late payments, and any write-off on rental or non-rental payments due.[13] Over time, RentBureau expanded its geographic coverage adding new properties and locations to the database.

Rent payments for each lease, whether active or closed, are recorded in a 24-digit vector representing the renter's payment performance over the previous 24 months from the month of reporting or the month the lease ended. The rent payments are coded as P (on-time payment), L (late payment), N (insufficient funds or a bounced check), O (outstanding balance at lease termination), W (write-off of rent at lease termination), or U (write-off of non-rent amount owed at lease termination). Since RentBureau only maintains a 24-month payment record for each lease, lease payment records are therefore left censored.[14]

We match the individual lease rental records to the metropolitan (MSA) area to study the effects of subprime activity on rental defaults.[15] We obtain micro-level mortgage data from the Home Mortgage Disclosure Act (HMDA) mortgage origination data for originated purchase loans on owner-occupied houses.[16] We then identify subprime mortgages using the Department of Housing and Urban Development (HUD) lists of subprime lenders.[17]

We subdivide the data based on the focus of our analysis. For example, we first examine the role that credit expansion via subprime lending played on residential lease risk. Since

[13]RentBureau also separately tracks collections on terminated leases.

[14]In some cases, the payment vector contains missing values. If the missing values are between two populated cells indicating on-time payments, then we record the missing values as on-time. Similarly, if the missing values occur at the end of the payment vector, we reclassify them as timely payments as long as they are posterior to the lease signing date. Otherwise, missing payments are treated as missing values, potentially biasing our rent risk measure downward.

[15]We match MSA numbers to leases using the 2009 MSA definitions published by the Office of Management and Budget (OMB). OMB published the 2009 MSA definitions in Bulletin No. 10-02, dated December 1, 2009. The same MSA designations are kept throughout the study.

[16]Enacted by the Congress in 1975, the HMDA legislation requires lending institutions to report the mortgage applications they receive in the metropolitan statistical areas they serve to the Federal Financial Institutions Examination Council. HMDA lists mortgage originations processed by lending institutions in the various metropolitan areas they serve. The data include property locations, applicant information, loan characteristics, and ultimate purchasers of mortgage loans. (www.ffiec.gov/hmda/)

[17]The lists are accessible at http://www.huduser.org/portal/datasets/manu.html. We note that not all loans made by these lenders were subprime and some conventional mortgage lenders also were extensively involved in subprime lending. HMDA also flags high-price mortgages, which are more likely to meet the subprime qualification. But this identifier is not available prior to 2004. Thus, we use the high-price mortgage indicator to test the robustness of the results.

subprime origination activity essentially ended in 2007 at the start of the financial crisis, we focus our initial attention on the period between 2002 and 2006. The second part of the empirical study focuses on the impact that changes in the homeownership rate had on residential lease risk, thus allowing us to expand the dataset to 2009 and thereby capture both the boom and bust in the U.S. housing market.

4 Multivariate Analysis

We now turn to our formal empirical analysis of the relation between subprime originations and defaults on leases. We restrict the analysis to properties located in MSAs that have a minimum of 30 leases per year and to leases with rent payments greater than $250 per month and less than $5,000 per month. As shown in Table 2, our sample contains 424,340 leases from 1,352 large multifamily properties located in 75 MSAs over the period from 2002 to 2006. Table A.2 in the Appendix lists the MSAs included in the final sample. Reflecting the fact that RentBureau is essentially a credit repository for large multifamily landlords, Table 2 shows that the average property covered by the database had 314 leases per year. In addition, Table 2 reveals the unbalanced nature of the panel as the number of MSAs covered by RentBureau increases from 43 in 2002 to 75 by 2006 with the average number of leases per MSA ranging from 747 in 2002 to 2,070 in 2006.

Table 3 shows the descriptive statistics for the final lease sample and reveals an interesting characteristic of the mortgage credit expansion.[18] First, we see significant variation across MSAs in terms of subprime and mortgage credit activities. For example, the average yearly growth in purchase mortgage originations ($\Delta ORIGINATIONS$) was 10.5% and ranged from a low of -62.6% in Ventura County, CA in 2005 to 182.8% in Brownsville/Harlingen, TX in 2001. Even though some MSAs experienced very modest growth in mortgage lending, most MSAs were significantly affected by the surge in subprime lending with the subprime origination activity accounting for 16.7% of all mortgage mortgage originations, on average,

[18] These descriptive statistics are from 2001 to 2006 since most of the variables are lagged.

across all MSAs and years. At the low end of the distribution, subprime origination activity accounted for 2.6% on average in Champaign-Urbana, IL in 2005, while at the high end Fayetteville, NC experienced an average subprime origination penetration of 52.4% in 2001.

In addition to heterogeneity in mortgage activity, Table 3 highlights other significant differences across MSAs. For example, house prices increased at an average rate of 9.2% per annum for our sample with some areas, such as Riverside-San Bernardino, CA and Naples-Marco Island, FL experiencing average annual price growths of more than 12% per annum during that 6-year period. We also see significant variation in the median home prices across MSAs, ranging from $75,000 to $659,000. Meanwhile, the average annual increases in market rent and per-capita gross personal income were 3.7% and 3.9%, respectively, highlighting the documented disconnect between house prices and these more traditional determinants of mortgage demand (Mian and Sufi, 2009). As a result, we also see substantial heterogeneity across MSAs in housing affordability as the NAHB/Wells Fargo housing opportunity index (*HOI*) ranges from 2.6% to 92.7%. As noted previously in Figure 3, the national housing opportunity index declined significantly during the housing bubble period.

Table 3 also shows that significant variation in the average annual rental default rate exists across MSAs. We note that, on average, the annual rental default rate is 5.7%. However, across MSAs, the annual default rate runs from 0% to 29.2%. In addition, we note that the average annual mortgage application denial rate is 20.1% and ranges between 8.2% in Boulder, CO in 2003 and 55.5% in Flagstaff, AZ in 2004.

Table 3 also provides an indication of how representative the sample is relative to the overall rental market. Although the RentBureau data does not contain information about the individual units (size, number of bedrooms, amenities, etc.), the data does report the monthly rent on the contract. Thus, we can obtain an indication of the quality of the unit by comparing the contract lease rent with the area fair market rent reported by HUD. We note that the average rent for a unit in the database is 1.15 times the fair market rent for units in its MSA (*RENT_LEVEL*). This implies that leases in the dataset are for units that are higher quality (more expensive) than the overall distribution of rental properties.

4.1 Default Models

We test our central hypothesis that increases in subprime mortgage activity altered the risk distribution in the rental market by estimating the riskiness of residential leases ($RISK$) as a function of the intensity of subprime mortgage lending at the MSA level ($SUBPRIME$) and a vector of control variables (X) as follows:

$$RISK_{i,t} = \alpha + \beta SUBPRIME_{i,t-1} + \gamma X_{i,t} + \varepsilon_{i,t}. \tag{4}$$

We measure the riskiness of residential leases through two empirical models. First, we estimate the aggregate riskiness of residential leases through a model of MSA level rental default indexes. We define the MSA i rental default index for month t as the average number of leases in MSA i that defaulted during month t divided by the total number of leases tracked in month t. Second, we confirm the findings of the aggregate default index by estimating a model of the probability of individual lease default that allows us to include a control variable that captures differences in individual leases characteristics. In this model, we define a lease default as whether a renter defaulted or missed a rental payment over the lease term.

In (4), our primary variable of interest is the amount of subprime mortgage activity experienced in each area. We also include a variety of variables to control for differences in mortgage credit, local demographic and economic conditions, local housing markets, as well as differences in individual unit lease characteristics.

Mortgage Market Variables

To test for the impact of subprime originations, we define a proxy for subprime mortgage activity as the percentage of subprime originations in MSA i at time t relative to the quantity of purchase mortgages originated in MSA i at time t ($SUBPRIME$).[19] Under the hypothesis

[19]We lag the subprime measure by one year because the HMDA data are published annually and do not

that subprime mortgage origination activity increased the risk of the rental population, we expect the marginal effect of *SUBPRIME* on lease defaults during the 2002-2006 period to be positive. We also control for the growth in subprime origination activity by including the lagged annual change in the share of subprime mortgage originations at the MSA level ($\Delta SUBPRIME$).

In order to accurately isolate the effect of subprime lending on lease defaults, we control for the impact of the general growth in mortgage lending by including the lagged percentage change in the quantity of purchase mortgage originations ($\Delta ORIGINATIONS$). The expected effect of $\Delta ORIGINATIONS$ is ambiguous since an expansion in mortgage credit can result from positive economic shocks (Mian and Sufi, 2009) or a decline in mortgage underwriting standards (Anderson, Capozza, and Van Order, 2008).

Credit Risk

We recognize that variation may exist in household credit risk across locations, however such variations are generally unobservable. Thus, we utilize the MSA mortgage application denial rate (*CREDIT_RISK*) as a proxy for local credit risk. We calculate the yearly mortgage denial rate for each MSA using HMDA data for both purchase and refinance applications. We include *CREDIT_RISK* to capture geographic differences in the level of area household credit risk as well as Δ*CREDIT_RISK* to capture temporal shifts in credit risk within an MSA.

Lease Characteristic

Although we do not have direct measures of household credit quality or property quality, we do observe the actual rent paid by the household. Thus, we include the ratio of individual gross rent to the local fair market rent (*RENT_LEVEL*) as a proxy for quality.[20] We expect *RENT_LEVEL* to be a proxy for unobservable household characteristics to the extent that household income is positively correlated with credit risk and higher quality buildings with higher rents cater to higher income households charge higher rents relative to the area fair

contain exact transaction dates.

[20]Fair market rent (FMR) estimates for each MSA are produced by HUD.

market rent.

Housing Market Conditions

Since the demand for owner-occupied housing is a function of area house prices, we control for the effect of recent (prior quarter) changes in housing prices within each MSA. We measure the change in house prices by the lagged change in the MSA's house price index (ΔHPI) produced by the Federal Housing Finance Agency (FHFA). In addition to the effect of recent changes in MSA house prices over time, we also examine differences in rental defaults between MSAs that experienced strong house price growth and those that did not. We introduce a dummy variable, labeled *HIGH_PRICE_GROWTH*, that is set equal to 1 if the MSA's average house price growth (using HPI) over the last three years is above the sample average and equal to 0 otherwise.

In addition to changes in MSA house prices, we also consider differences in lease defaults relative to MSA house price levels. For each quarter, we classify MSAs into quartiles based on the lagged median house prices.[21] We then construct a low-median house price variable (*LOW_HOUSE_PRICE*) that is equal to 1 for MSAs belonging to the bottom quartile and 0 otherwise.

We also control for overall growth in the supply of rental housing by including the number of units in multifamily building permits issued during the year in each MSA (*SUPPLY*). It is lagged two periods to reflect typical time between permitting and construction completion. Finally, we include the annual change in the MSA fair market rent (ΔFMR) to capture regional differences in rental growth rates.

Local Demographic and Economic Condition Variables

To control for cross sectional differences in MSA economic conditions as well as temporal changes in macroeconomic conditions, we include in (4) the monthly MSA unemployment rate (*UNEMPLOYMENT*) and the change in the monthly unemployment rate

[21] MSA median house prices are available from CoreLogic and published by the National Association of Home Builders (NAHB).

(Δ *UNEMPLOYMENT*).[22] The level of unemployment (*UNEMPLOYMENT*) controls for differences in economic base activity across MSAs with relatively higher unemployment suggesting less opportunities for renters to move to homeownership. We include the change in unemployment from from the previous period (Δ *UNEMPLOYMENT*) to capture local economic shocks through time.

We include two measures of household incomes to reflect the impact of regional variations in income levels. First, we create a dummy variable (*HIGH_INCOME*) that is set equal to one for MSAs with average household incomes greater than the national average household income at time t. Next, we control for the potential that a positive economic shock resulting in higher average personal income, as measured by the lagged change in the MSA's per-capita gross annual personal income ($\Delta INCOME$), will reduce the overall household credit risk and increase household movement from renter status to home ownership (corresponding to the leftward shift in $r(\Phi)$ to $r'(\Phi)$ in Figure 8.)[23]

To control for changes in the demand for rental units, we include the percentage of the state's population in the 20-year to 34-year age group relative to the state's annual population, lagged by one period (*RENTERS*).

To control for differences in housing affordability across MSAs, we use the NAHB/Wells Fargo Housing Opportunity Index (*HOI*), which compares the median family income to median house prices quarterly at the MSA level.[24] We include the lagged value of that index (*HOI*) and a high median income dummy (*HIGH_INCOME*) that is equal to 1 if the lagged value of the MSA's median family income is above the national median family income.[25]

Finally, we include a series of dummy variables to control for state and year fixed

[22]Local monthly unemployment rates are obtained from the Bureau of Labor and Statistics (BLS).

[23]We obtain MSA average household incomes from Bureau of Economic Analysis (BEA).

[24]The *HOI* for a given area is defined as the share of homes sold in that area that would have been affordable to a family earning the local median income, based on standard mortgage underwriting criteria. NAHB assumes that a family can afford to spend 28 percent of its gross income on housing. The HOI is the share of houses sold in a metropolitan area for which the monthly median income available for housing is at or above their monthly mortgage costs. http://www.nahb.org/reference_list.aspx?sectionID=135

[25]The annual median family income estimates for metropolitan areas are published by the Department of Housing and Urban Development.

effects. The state fixed-effects control for possible systematic differences in regional economic conditions and mortgage market regulations. The year fixed-effects, on the other hand, control for national factors, such as general economic and capital market conditions and changes in mortgage underwriting standards, not captured by the variables outlined above.

4.2 Endogeneity and Identification

One concern in estimating equation (4) arises from the potential endogenous relation between local area risk and subprime origination activity. For example, if areas that have higher concentrations of subprime borrowers (and by extension greater subprime mortgage origination activity) are inherently riskier than areas with lower subprime origination activity, then it is possible that any positive association between subprime origination activity and rental defaults could arise from this systematic difference in local economic risk. Thus, we rely on both the preponderance of the evidence to demonstrate a causal link and a variety of econometric methods to minimize the impact of potential endogeneity.

First, we estimate equation (4) using a variety of model specifications and sample subsets to confirm the causal relation. The results presented in section 4.3 show that the estimated effect of subprime origination activity on rental defaults is robust to these alternative specifications and samples. Second, we explicitly account for the potential endogenous relation problem by lagging both the subprime and mortgage origination variables. This is a common method of handling a possible endogenous relationship, assuming that the error terms are not correlated over time.[26] Third, our model specification includes a number of control variables that are designed to specifically capture differences in local economic risk. As a final robustness check, we re-estimate equation (4) using an instrumental variables (IV) framework. Of course, the IV method relies on the ability to find a valid instrument that captures demand for mortgage credit but is uncorrelated with rental default risk. In order to obtain a valid instrument, we rely on the natural segmentation in the mortgage market

[26]However, we acknowledge that some persistence exists in mortgage origination activity and thus the inclusion of lagged variables is not a perfect control.

based on whether the mortgages are originated to refinance an existing debt or to purchase a new home. We discuss the IV method, choice of instrument, and estimation results in section 4.4.6 and demonstrate again the robustness of our initial estimated effect of subprime origination activity on rental defaults.

4.3 Estimation Results

MSA Default Indices

Table 4 reports the coefficients for the ordinary least squares (OLS) estimation of various specifications of equation (4). The dependent variable is the logisitic transformation of the aggregate monthly MSA level lease default indices. Our primary variable of interest is *SUBPRIME*, the percentage of subprime originations in a MSA relative to the quantity of purchase mortgages originated in that MSA. We proceed sequentially from model (1) to model (4) adding control variables in order to confirm that the estimated coefficient for *SUBPRIME* is not sensitive to our model specification. We note that across the four models, the estimated coefficients for *SUBPRIME* are positive, qualitatively similar, and statistically significant at the 1% level. Thus, we feel that our inferences concerning the impact of subprime origination activity on lease default rates are not conditional upon the model specification.

Since the estimated coefficients across the four models reported in Table 4 are qualitatively the same, we confine our discussion to our preferred specification (model 4) that includes the full set of economic and market control variables. We find the estimated coefficients for subprime lending activity (*SUBPRIME*) on lease defaults is positive and statistically significant. The coefficients indicate that a 1% rise in subprime mortgage originations translates to a 1.91% increase in lease default index.[27] Therefore, consistent with the predictions from our theoretical model, we see that the expansion of subprime lending during the

[27]Since the dependent variable is a logistic transformation of the default rate, we evaluate the marginal effects of the estimated coefficients assuming a 1% increase in the subprime origination percentage from its sample mean, holding all variables constant at their sample means.

housing bubble negatively affected the risk profile of residential leases. We also include the growth in the overall mortgage market ($\Delta ORIGINATIONS$) and find its estimated marginal effect on lease defaults is much smaller but also statistically significant. The marginal effect based on the coefficient indicates that a 100 basis point growth in overall purchase mortgage originations results in a 0.01% increase in the average lease default rate. Thus, the results confirm our hypothesis that it was the expansion in subprime lending and not the overall growth in mortgage lending that had the largest effect on the rental market. This finding is intuitive as renters were less likely to have access to conventional mortgage financing prior to the development of subprime products (Bernanke, 2007).

We also see that many of the variables designed to control for differences in risk across MSAs are significant and have the correct sign. First, we note that the MSA level annual mortgage application denial rate ($CREDIT\_RISK$) is positive and statistically significant (at the 1% level). The coefficient confirms our intuition that MSAs with higher economic uncertainty, as reflected in higher mortgage application denial rates, also have higher levels of lease defaults. The estimated coefficient implies that every 1% increase in mortgage denial rate corresponds to a 2.74% increase in the rental default rate.

Turning to the housing market control variables, we find that changes in house prices (ΔHPI and $HIGH\_PRICE\_GROWTH$) are not statistically associated with lease defaults (at the 5% level). However, we do find that areas with low house price levels (LOW_HOUSE_PRICE) have significantly higher lease defaults. The estimated coefficient indicates that the rental default rate in areas in the lowest quartile of house prices (LOW_HOUSE_PRICE) is 11.58% more than lease default rates in other MSAs. These findings are consistent with the results reported by Ioannides and Kan (1996) that house price appreciation discourages renters from becoming homeowners. We also see that the coefficient for annual increase in the MSA fair market rent (ΔFMR) is positive and statistically significant. As expected, areas that experienced greater rental growth rates also saw increased lease default rates. Finally, we find the expected result that the estimated coefficient for $UNEMPLOYMENT$ is negative (although not significant) suggesting that areas with higher unemployment have lower lease default rates.

Probability of Lease Default

Next, we re-estimated equation (4) at the individual lease level in order to include a control variable for differences in lease characteristics. Model 1 in Table 5 reports the marginal effects for the probit estimation of the probability of lease default, where the dependent variable equals one if the lessee defaults on the lease and zero otherwise.

Confirming the results from the aggregate MSA level default risk model (Table 4), we find a positive and statistically significant marginal effect for the share of subprime mortgage originations (*SUBPRIME*) on the probability of lease default. The marginal effect indicates that a 1% increase in the share of subprime mortgage originated in an area increases the probability of lease default by 0.3% per month. We also find positive and significant effects for the annual change in subprime origination share as well as the annual change in purchase mortgage originations.

Turning to the various control variables, we find effects consistent with our prior expectations. For example, we see that a 1% increase in the overall MSA credit risk (as captured by an increase in the mortgage denial rate) increases the probability of default by 0.54%. In addition, the marginal effect for areas with low house prices (*LOW_HOUSE_PRICE*) is positive and significant indicating that lessees in MSAs with relatively low house prices are 3.65% more like to default on their rental contracts than renters in higher MSAs with higher average house prices. Furthermore, we also see that the probability of lease default is greater in MSAs with higher changes in average fair market rents and greater supply of multifamily units. We note that a 1% increase in the supply of rental units corresponds to a 1.61% increase in the probability of lease default. Overall, the house price control variables support the hypothesis that areas with a larger rental supply and competition from lower priced houses have higher lease default rates than areas with less affordable housing opportunities.

Turning to the local demographic and economic control variables, we first note that

MSA income growth ($\Delta INCOME$) is negatively and significantly related to the probability of lease default. The marginal effects suggest that a 1% increase in per-capital income is associated with a 0.19% decrease in the probability of lease default. In addition, we see that renters in MSAs with high average income levels (*HIGH_INCOME*) are 1.2% less likely to default than renters in lower income cities.

Looking at the impact of MSA unemployment, we find that renters in cities with higher levels of unemployment are less likely to default but that renters in cities that experienced an increase in unemployment are more likely to default. Since the level of unemployment controls for differences in economic base activity across MSAs and the change in unemployment from from the previous period captures local economic shocks through time, the positive and significant effect associated with Δ*UNEMPLOYMENT* suggests that an increase in unemployment increases the rate of lease defaults in the area in the long run, consistent with a shift in $r(\Phi)$ in Figure 8 to the right since the renter population becomes riskier. On the other hand, the negative and significant effect for $\Delta INCOME$ suggests that a positive economic shock resulting in higher average personal income reduces the overall household credit risk (corresponding to the leftward shift in $r(\Phi)$ to $r'(\Phi)$ in Figure 8).

Finally, we note that the variable *RENT_LEVEL*, which measures the ratio of contract rent to the MSA's prevailing fair market rent at the time of lease origination, is negative and statistically significant. The marginal effect indicates that tenants who can afford rents 1% higher than the MSA's fair market rent are approximately 0.10% less likely to default.

Cox Proportional Hazard

As a robustness check on the inferences from the probit estimation, Model 2 in Table 5 reports the hazard ratio estimates from the estimation of a Cox proportional hazard model of lease default. This model assumes that a renter exits the rental contract either by completing the contract or by defaulting, where the time to default is a random variable with a continuous probability distribution.[28] The Cox proportional hazard specification allows us to include time-varying controls for local economic risk. For example, rather than controlling for the unemployment rate at lease origination, Model (2) includes the time-varying monthly unemployment rate.

With two exceptions, we note that the hazard rates reported under Model (2) are consistent with the probit estimates for individual lease default. The first exception is that the variables controlling for MSAs that had high house price growth rates (*HIGH_PRICE_GROWTH*) and changes in MSA house price indexes (ΔHPI) are now statistically significant where they had been insignificant in Table 4. The hazard rates suggest that renters in cities that experienced high house price growth rates are 13.7% more likely to default than renters living in cities with slower house price appreciation. In addition, we see that a 1% increase in the house price index over the previous period results in a 2% reduction in the hazard of renter default. The second significant difference is that the unemployment variables are no longer significant.

However, estimated hazard ratios for the variables related to mortgage credit expansion are statistically significant and consistent with the results found in Table 4. For example, the estimated hazard ratio for *SUBPRIME* implies that a 1% increase in the share of subprime mortgages originated in an MSA increases the hazard of renter default by 1.5%.

Thus, to summarize, our three models of rental contract risk verify the theoretical predictions that mortgage credit expansion during the previous housing boom resulted in an increase in the overall riskiness of the renter population as measured by an aggregate MSA level rental default index as well as by an examining individual renter probabilities of default.

[28]Following Cox (1972), we specify $\lambda_i(t)$, the hazard rate of default of lease i at time t, as

$\lambda_i(t) = \exp(\beta' X)\lambda_0(t)$

where λ_0 is the baseline hazard. Equation (5) is estimated via maximum likelihood.

4.4 Robustness Checks

4.4.1 Temporal Variation in MSAs

One concern is that our results may reflect the changing nature of the RentBureau lease coverage through time. As noted in Table 2, the number of locations covered by RentBureau increases substantially over the sample period. Thus, to confirm that the expansion in the number of MSAs is not responsible for the results supporting the hypothesis that subprime credit expansion increased rental default risk, we re-estimated the lease default model using only leases originated in the MSAs covered by RentBureau during the complete period.[29] We report the marginal effects from the probit estimation of lease default as model (1) in Table 6. First, we note that the marginal effect of subprime lending (*SUBPRIME*) on lease defaults remains statistically significant with a slightly larger effect as in the full sample model (Table 5). The marginal effect indicates that a 1% rise in subprime mortgage originations translates roughly to a 0.33% increase in the probability of lease default. Furthermore, with the exception of the unemployment level and the change in MSA house price index, we note that the various control variables retain their statistical and economic significance. Thus, we feel that the results controlling for MSA across time is compelling evidence that temporal changes in the RentBureau panel are not biasing our primary result.

4.4.2 Property Survivorship Bias

During the housing boom, a number of multifamily rental properties were converted into single-family condominium units and removed from the rental market. In general, these properties were at that upper end of the rental market, and hence most likely occupied by wealthier renters. Thus, to confirm that our observed increase in lease defaults is not due to rental property conversions, model (2) in Table 6 reports the marginal effects for the probit estimation of the lease default model for only those properties with reported data in each year. We see that the marginal effect of subprime originations on lease defaults is

[29] The Appendix reports the MSAs that had full coverage by RentBureau during the sample period.

even stronger after controlling for property survivorship and the effects of other explanatory variables are unchanged. We now find that a 1% increase in subprime mortgage originations implies a 0.47% increase in the probability of lease default. Therefore, we conclude that rental property conversions were not a determinant factor in higher lease defaults.

4.4.3 Migrating Renter Groups

Having documented the positive impact of subprime lending on rental lease defaults, we next examine which renter groups switched from renting to homeownership. For this exercise, we classify leases into quartiles by MSA and cohort year according to the contracted gross rent, labeled *RENT1* for the bottom quartile to *RENT4* for the top quartile. We then interact the rent quartiles with the subprime variable in order to capture the impact of subprime lending on the various renter groups. Column 3 in Table 6 summarizes the marginal effects from the probit estimation of the lease default incorporating these interaction variables.

The positive and significant impact of subprime lending on lease defaults for the reference group composed of leases belonging to the lower rent quartile, along with the positive coefficients of the interaction variables, shows that all renter groups experienced a significant increase in lease defaults as subprime credit expanded. Furthermore, the impact of subprime lending on lease defaults appears to increase with gross rent as expected. For example, we see that a 1% increase in subprime originations corresponds to a 0.04% increase in lease defaults in the lowest rent group and a 0.07% increase in the top rent quartile.[30] To summarize, all renter groups experienced a significant increase in lease defaults as subprime lending expanded, but as expected, holders of more expensive leases experienced the strongest effect from subprime origination activity suggesting that the pool of renters in the higher rent bracket became riskier.

[30] 0.07% = 0.04% + 0.03%.

4.4.4 Sensitivity to Subprime Definitions

Another potential concern is our choice of mortgage origination and subprime metric. Thus, in Table 7, we examine the sensitivity of the previous results to choice of mortgage origination and subprime metrics. First, we report results using the Department of Housing and Urban Development (HUD) list of subprime lenders to identify the percentage of subprime originations in each market. Second, we use the HMDA definition of high-priced mortgages to identify subprime originations. For each subprime definition, we examine the sensitivity of the result to whether the mortgage market is defined by the number of mortgage originations (Number) or dollar volume of originations (Dollar Vol.). The results based on these alternative metrics confirm the previous significant positive relation between subprime lending and residential lease defaults, suggesting that our results are not driven by the choice of purchase mortgage or subprime metrics.

Overall, these results provide further evidence in support of the hypothesis that the expansion of subprime lending during the recent housing boom adversely affected the residential rental market. However, caution may be required when interpreting these results since the analysis does not directly control for renter characteristics. Nevertheless, it is important to note that we applied a conservative approach to identifying lease defaults. Missing payment records in the original RentBureau data were almost always systematically reclassified as paid on time. Thus, the number of lease defaults used in the analysis is certainly lower than the actual figures, resulting in a downward bias in our findings.

4.4.5 Homeownership Effects

In the previous sections, we tested for the effect of subprime mortgage credit expansion on rental default rates. If our hypothesis is correct, then as subprime credit contracts and disappears following the financial crisis, we should observe a decrease in rental default as the homeownership rate declines. We test this hypothesis by substituting the homeownership rate for subprime mortgage originations. If subprime lending increased homeownership causing higher lease defaults because of the migration of better quality renters into homeownership, then we should see a similar effect using the homeownership rate.

Table 8 summarizes the estimation results based on the homeownership rate. *HOMEOWN* is the one-year lagged MSA homeownership rate or average state homeownership rate for MSAs with missing homeownership data.[31] The variable *POST2006* is a lease-year dummy variable set to 0 for leases originated before 2007 and 1 for leases originated in and after 2007. We interact *POST2006* with homeownership to capture changes in the marginal effect of *HOMEOWN* on lease defaults as the housing downturn gained momentum. The marginal effect of homeownership from 2001 to 2006 (Model (1) in Table 8) is similar to the result obtained with the subprime variable. Furthermore, all other variables behave exactly as previously predicted. The extension of the analysis to 2009 in Model (2) shows a similar effect of homeownership on lease defaults. However, the negative marginal effect for the interaction of the post 2006 dummy variable with homeownership rate indicates that, following the housing boom, the riskiness of the rental population declined (the probability of lease default declined) as more households now remain in the rental market. Overall, we find that the substitution of homeownership for subprime originations strengthens our theoretical predictions that as underwriting standards tightened and economic risk increased, the riskiness of the renter population should decline.

4.4.6 Instrumental Variables Estimation

As noted in section 4.2, equation (4) may suffer from a potential endogenous relation between local area risk and subprime origination activity. Thus, in this section we report the results from estimating equation (4) using an instrumental variables (IV) framework. In order to find an instrument that predicts changes in subprime mortgage originations across MSAs but is unrelated to changes in the risk distribution of renters, we rely on the fact that demand for mortgage credit arises from households purchasing houses (purchase mortgages)

[31] Data from Census Bureau at http://www.census.gov/hhes/www/housing/hvs/annual11/ann11ind.html

as well as from households seeking to refinance existing mortgages (refinance mortgages). Over the past two decades, as the costs associated with mortgage originations declined, the average shares of mortgage originations that are associated with household refinancing activity increased substantially.[32] To the extent that mortgage brokers expanded staffing to meet the increasing refinancing demand and yet also had extra capacity (a reasonable assumption), then the number of mortgage brokers in a particular market should be weakly related to purchase mortgage demand arising from renters migrating into ownership. Thus, we use the number of mortgage brokers in each MSA (*BROKER*) as our instrument under the theory that mortgage broker employment is based on the total demand for mortgage credit (purchase and refinancing). As a result, the number of mortgage brokers in a MSA should have low correlation with changes in the riskiness of the rental population since a significant source of mortgage credit demand (refinancing activity) is invariant to the population of renters in the MSA.

In order to confirm the statistical validity of the number of mortgage brokers as an instrument, we first verified it's orthogonality by estimating the following regression:

$$BROKER_{i,t} = \alpha + \beta\varepsilon_{i,t} + \mu_{i,t} \tag{5}$$

where $\varepsilon_{i,t}$ is the OLS residual from model (1) reported in Table 5 and *BROKER* represents the number of mortgage brokers operating in MSA i at month t. Linear estimation produced the following estimated coefficients with robust standard errors reported in parentheses:

$$BROKER_{i,t} = \underset{(0.014)}{0.737^{***}} + \underset{(0.024)}{0.017}\varepsilon_{i,t} + \mu_{i,t} \tag{6}$$

The *F-statistic* testing the null hypothesis that $\beta = 0$ is 0.49 (with a p-value of 0.48). Thus, we cannot reject the null hypothesis, which indicates that our instrument (*BROKER*) is orthogonal and thus may be a valid instrument. We also confirmed the validity of our

[32] The Mortgage Bankers Association reports that refinancing activity accounted for 53% of all mortgage originations over the period between 2000 and 2010.

instrument in the probit model of lease default (model 2) by noting that the Wald test for our instrument has a χ^2 statistic of 27.6 (significant at the 1% level).

Finally, Table 9 reports the estimated coefficients for the IV specification for the lease default rate model and the individual lease default model. The results for the first-stage of the IV model shows that the coefficient of *BROKER* is positive and statistically significant at the 1% level. The significance of *BROKER* in the first-stage along with the results indicating the its orthogonality give us confidence that we have identified a valid instrument. Although the statistical tests and economic logic regarding the mortgage market give us confidence in the validity of our instrument choice, we acknowledge that identifying a pure causal instrument that can predict subprime origination while being unrelated changes in the risk distribution of renters is virtually impossible. Thus, we confine our discussion of the IV estimation as a robustness check in support the previously reported results and leave it to the reader's discretion as to whether the IV results below support the preponderance of the evidence.

As seen in Table 9, the results for the second stage IV models continue to confirm the causal link between subprime origination activity and lease defaults. For example, in the MSA level default index regression (model 1), the estimated coefficient for *SUBPRIME* is positive an statistically significant indicating that a 1% rise in subprime origination activity translates to a 3.3% increase in the lease default index.[33] This effect is similar to the 2% effect observed for the OLS estimation. Furthermore, we observe that the estimated coefficients for the control variables are broadly consistent with the previous models indicating that our model specification is stable. Comparing the estimated coefficients for the probit model of lease defaults (model 2) again shows that the IV estimation results are consistent with our previous results. Thus, we conclude that the observed subprime mortgage effect is qualitatively similar to the primary results reported in the previous sections, adding further evidence to the validity of the observed impact.

[33]The marginal impact was estimated assuming a 1% increase in the subprime origination percentage from its sample mean, holding all other variables constant at their sample means.

5 Potential Rental Income Losses

The previous section shows that lease risk, characterized as the first non-timely rent payment, increases with subprime originations in the area. This positive relation between lease defaults and subprime origination activity corroborates the difference in lease defaults we found between low-subprime and high-subprime MSAs as documented in Figures 1 and 2, and Table 1. In this section we estimate and compare potential rental income losses in high-subprime and low-subprime metropolitan areas. We classified MSAs into quartile buckets according to the ratio of purchase subprime originations to total mortgage originations during the subprime lending boom from 2001 to 2006, with the 1st and 4th quartiles classified respectively as the low-subprime and high-subprime MSAs.

Unfortunately, the lease performance database does not directly contain information on rent losses. However, RentBureau reports late-payment and unpaid-check counts over the last 24 months prior to and including the last lease performance-update month. We use these statistics to estimate potential rent losses at the lease level. We classify leases by year according to the last year of performance update in order to assess average yearly losses. This classification implicitly assumes that leases last updated in a specific year constitute a representative sample of leases outstanding that year. However, as delinquent renters are unlikely to have their leases renewed, our estimated potential losses may be overestimated but should yield reliable estimates of differences in average losses between the low-subprime and high-subprime areas.

Table 10 reports average potential rental income losses in the two subprime subgroups from 2002 to 2009. The top and bottom halves of the table are average annual percentage potential rental losses based on late-rent counts (*Metric 1*) and late-rent and unpaid-check counts (*Metric 2*), respectively. Both metrics yield higher average annual losses in high-subprime MSAs compared to low-subprime areas, with *Metric 2*, as expected, resulting in higher loss estimates than *Metric 1*. On average, we see that high-subprime MSAs record 38.6% higher potential losses (5.75% vs. 4.15% based on *Metric 1*) and the difference is statistically significant at the 1% level.

6 Lease Defaults and Rent Levels

As discussed in the introduction, one of the potential consequences of policies designed to increase homeownership is that it could lead to the unintended consequence of a higher credit risk renter population, which would lead landlords to charge higher rents to compensate for the greater risk. Since the previous sections have demonstrated the link between default on residential leases and subprime credit expansion, we empirically test the link between rents and rental defaults by estimating the following reduced-form model of monthly average MSA rents ($R_{i,t}$):

$$\begin{aligned} R_{i,t} &= \alpha + \beta_1 R_{i,t-1} + \beta_2 RISK_{i,t-1} \\ &\quad + \beta_3 VACANCY_{i,t-1} + \gamma MSA + \theta RENT + \varepsilon_{i,t} \end{aligned} \tag{7}$$

where $RISK_{i,t-1}$ is the previous month MSA-level rental default index, and $VACANCY_{i,t-1}$ is the previous year state level residential vacancy rate. We also include MSA level fixed-effects (MSA) and rent level tercile fixed effects ($RENT$) to control for unobservable differences in risk across location and rent levels. We estimate equation (7) over the 2001 to 2007 period in order to isolate the impact of rising rental default rates resulting from higher quality renters migrating into homeownership due to the credit expansion in the mortgage market. We include the average rental vacancy rate in order to control for the effects that shifts in the relative supply and demand for rental housing may have on market rents. For example, an increase in the vacancy rate resulting from either an increase in the supply of rental units or a decline in rental demand should correspond to a decline in the market rent.

Panel A in Table 11 shows the estimated coefficients for the simple regression of monthly average MSA rents on the monthly aggregate rental default index. Column (1) shows the estimated coefficients for the full sample while columns (2) through (4) show the estimated coefficients for the sample segmented into rent level terciles. As expected, the positive and significant coefficients for lagged rent indicate that average MSA rents display significant persistent through time. We also see that, as anticipated, the estimated coefficients on the lagged aggregate MSA rental default index are also positive and significant indicating that increases in residential risk (as indicated by an increase in the prior months rental default rate) correspond to increases in average rents. Furthermore, comparing coefficients across columns (2) through (4) we see that the effect increases as rent levels increase. Finally, we also see that areas with higher rental vacancy rates have lower rents.[34]

Panel B in Table 11 reports the estimated coefficients for the simple model of monthly average rent at the property level on the lagged monthly property level default index. In this regression, we also include the residual from the regression of the property level default index on the MSA level default index in order to capture the individual property level default risk that is independent of the overall MSA level default risk. Columns (2) through (4) again report the regression results for the rent terciles at the property level, which provides a cleaner control for differences in unit size and amenities (e.g. higher floors, views, etc.) at the property level. As in Panel A, we find that the estimated coefficients on the lagged aggregate MSA rental default index are positive and significant indicating that increases in residential risk (as indicated by an increase in the prior months default rate) correspond to increases in average rents. We also find a positive and statistically significant coefficient for the default index residual indicating that higher levels property specific risk (over and above the general MSA level risk) lead to higher subsequent rents. The individual rent tercile regressions confirm finding that the effect of lease defaults on rents increases as rent levels increase.

[34]We also estimated the same model at an annual frequency using the HUD fair market rent as the dependent variable and find a similar effect.

7 Rental Defaults and Property Performance

In this section we examine the impact of the documented deterioration in the credit quality of the renter population on multifamily property investments. We expect that if lease default risk impacts property cash flows, then it should negatively affect the performance of those properties. Furthermore, absent any substantial information asymmetry regarding property performance, the positive correlation between subprime originations and rental defaults may lead to investors demanding higher expected returns on those investments. As an initial step towards uncovering the nature of the relation between property investments and rental defaults during the subprime mortgage expansion, we conduct univariate regressions of property returns and capitalization rates on rental default rates at the MSA level.

For the purpose of this analysis, we construct two measures of MSA rental defaults using the data from RentBureau. Our first rental default measure classifies on-time rent payments (Ps) as zero and payment delinquencies as one and then computes the MSA's average score each quarter, provided that there are at least 30 leases outstanding that quarter. This rental default index, labeled *DEF_INDEX_1*, is therefore increasing in the number of rent payment defaults. Our second rental default index, labeled *DEF_INDEX_2*, considers the severity of payment delinquencies using a simple linear scale. On-time payments are still coded as zero, late payments (Ls) and insufficient funds or bounced checks (Ns) coded as one, and the more severe default events (outstanding balances and write-offs (O, W, and U)) are coded as two to reflect their higher probabilities of substantial monetary losses.

First, we explore the contemporaneous relation between rental defaults and property returns. We proxy multifamily property returns, the dependent variable, using the quarterly income returns and total returns on the National Council of Real Estate Investment Fiduciaries (NCREIF) multifamily property index (NPI), and the explanatory variable is the contemporaneous quarterly rental default rate at the MSA level (*DEF_INDEX_1* or *DEF_INDEX_2*).[35] The resulting data sample is an unbalanced panel of 625 observations,

[35]NPI city returns are matched to MSAs.

representing 51 MSAs and 24 quarterly periods from 2001 to 2006. Columns 1 and 2 in Table 12 summarize the results of the MSA fixed-effect univariate panel regressions of multifamily income returns on lease defaults. The coefficients of both *DEF_INDEX_1* and *DEF_INDEX_2* confirm our expectation; they are negative and significant, indicating higher rental defaults are associated with lower quarterly income returns. Thus, a negative cash flow shock will adversely affect performance immediately. For example, the estimated coefficient of *DEF_INDEX_1* indicates that a 1% increase in rental defaults results in a 0.16% decrease in the average annual income property return. However, the regressions of total returns on lease defaults in columns 3 and 4 in Table 12 yield inconclusive results. Since total return is composed of income return and capital appreciation, the insignificant relation may be due to appreciation in multifamily property values stemming from other factors. However, considering the shortcomings of the NCREIF return data, we believe the results in Table 12 represent strong preliminary evidence of the negative effect of the deterioration in the residential rental market as a result of the subprime expansion on property performance.

Next, we directly consider the effect of higher rental defaults on property values. If investors believe the negative shock on rental cash flows to be persistent, then property values should reflect such an expectation. We investigate this question by examining the relation between variations in multifamily property capitalization rate (cap rate) spreads and rental default indices at the metropolitan level. Since cap rates are forward looking, we assume that at time t investors form expectations about next period's rental default rates based on *t-1* defaults.[36] Therefore, we explore the relation between average quarterly cap rate spreads over the risk-free rate and the 1-period lagged values of our rental default indices, while controlling for variations in term-structure spread (*TERM*) and mortgage rate risk premium (*MORTG_PREM*). We use average MSA cap rates for multifamily property transactions produced by Real Capital Analytics (RCA).[37] Our dataset contains 623 quarterly

[36] This is mainly a matter of convenience because the time series is relatively short for an adequate modeling of the dynamics of rental defaults.

[37] The RCA dataset is based on transactions of $5 million and greater. We exclude observations based on one property transaction during the quarter.

observations across 40 MSAs from 2001 to 2006. We use the 3-month TBill rates as the risk free rate. *TERM* and *MORTG_PREM* are the 10-year constant maturity treasury bond rate minus the 3-month TBill rate and the 30-year FRM rate minus the 10-year constant maturity treasury bond rate, respectively.[38].

Table 13 presents the results of the MSA panel regression estimations. As expected, the estimated coefficients for *DEF_INDEX_1* and *DEF_INDEX_2* are positive and significant, showing the positive (negative) effect of rental defaults on cap rate spreads (property values). As expected, the effects of *TERM* and *MORTG_PREM* on cap rate spreads are also positive and highly significant. Clearly, investors appear to take into consideration the documented adverse effect of subprime lending on rental cash flows. For example, the estimated coefficient of *DEF_INDEX_1* implies that a 1% increase in an MSA's rental default index results in a 2.1 basis-point increase in the average cap rate. In other words, for a property initially valued at $10 million at the average capitalization of 6.93%, a 1% increase in the MSA default index translates to a $30,211 reduction in property value. To put this into perspective, the average default rate increased by 4.34% from 2002 to 2006, implying that property values would have fallen by $131,120 during that period, all else constant. Obviously, the adverse effect of rental defaults was small relative to the substantial opposing effect from declining interest rates during this period that caused substantial compression in cap rates.

8 Conclusion

A large and still growing body of research has investigated the various aspects of the past mortgage credit expansion, particularly its subprime component, and the resulting financial crisis following the boom in the U.S. housing market. However, no study has examined the potential spillover on the residential rental market. Yet, the development of exotic mortgage products and the widespread use of risk-based pricing, along with the easing of underwriting

[38]The interest rates on treasuries and 30-year fixed-rate mortgage interest rates are from the Federal Reserve of St. Louis. (http://research.stlouisfed.org/fred2/categories/116)

standards, allowed households previously excluded from the mortgage market to have access to mortgage financing and achieve their lifetime objective of owning a home, to the detriment of the residential rental market as low risk renters moved into homeownership.

We document a significant positive relationship at the MSA level between residential lease defaults and the level of the subprime originations and a significant deterioration of the renter pool over time in areas with substantial subprime lending activity. Overall, our analysis demonstrates an interconnected real estate market such that an exogenous shock in one part of the market inevitably produces ripple effects on the other sectors. Although estimating a conclusive causal link is beyond the realm of most social science research, we rely on a preponderance of evidence using a variety of econometric specifications and techniques to reach our conclusion. Our results across a variety of model specifications, econometric estimation techniques, and sample selections consistently show that a one percent increase in subprime mortgage origination activity corresponds to an approximately 1.9 percent increase in the rental market lease default rate.

The increase in lease defaults during that period certainly affected the riskiness of cash flows generated from rental multifamily properties. We provide preliminary evidence of the negative impact of the deterioration in residential renter credit quality on property performance. However, an in depth examination of the impact of subprime lending on the performance of multifamily properties and publicly-traded real estate firms specialized in that property type is worthwhile.

Finally, the results from our study provide an important cautionary note when evaluating the benefits associated with public policies. Our study demonstrates that policies designed to promote a particular social outcome in an effort to capitalize on its perceived external benefits could result in unintended consequences for another segment of society. In light of this warning, we demonstrate how the expansion of mortgage credit that provided the benefits of homeownership to a large segment of the population may have resulted in higher rental rates for the segment of the population that remained in the rental market. Thus, to the extent that a larger portion of the lowest income segment of the population remains in the rental market, the expansion in mortgage credit may have had a disproportionately negative impact on this segment of the population least able to bear the consequences of the increased rental rates that resulted from the shift in the rental population risk profile.

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Table 1: Simple Hazard Analysis

	2002	*2003*	*2004*	*2005*	*2006*
SUBPRIME	0.9281	0.9932	1.3069***	1.4421***	1.2811***
	(-1.17)	*(-0.16)*	*(8.23)*	*(14.13)*	*(12.07)*
N	2,484	4,894	9,350	15,240	22,623
LR χ^2	1.37	0.02	67.7	199.6	145.6

Note: *SUBPRIME* is set equal to 1 in high subprime MSAs and 0 otherwise. MSAs are classified into quartiles according to the percentage of purchase subprime mortgages originations in the area from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are areas in the 4th quartile. The reported figures are the marginal effect of *SUBPRIME* on the hazard rate with the t-statistics in parentheses ($*$ p $<$ 0.10, $**$ p $<$ 0.05, $***$ p $<$ 0.01).

Table 2: Distribution of Leases by Origination Year

		2002	*2003*	*2004*	*2005*	*2006*	*Total*
Leases		32,126	49,264	74,743	112,961	155,246	*424,340*
Properties		342	490	785	1,093	1,352	*1,352*
	Avg. leases	94	101	95	103	115	*314*
	Min. leases	5	5	5	5	5	
	Max. leases	646	793	722	1,320	1,468	
MSAs		43	49	56	64	75	*75*
	Avg. leases	747	1,005	1,335	1,765	2,070	*5,658*
	Min. leases	33	43	32	32	36	
	Max. leases	8,507	13,008	20,617	26,557	26,778	

Note: Leases are classified by cohort year, the year of the first rental payment recorded in the RentBureau database. For each cohort year, only MSAs with at least 30 leases and properties with more than 4 units are retained, resulting in the final sample containing 75 MSAs, listed in the Appendix (Source: Experian RentBureau)

Table 3: Descriptive Statistics

Variable	Mean	Std Dev	Min	Max
Mortgage Credit Conditions				
Annual share of subprime mortgages to the quantity of purchase mortgage originations at the MSA level (*SUBPRIME*)	16.7%	8.0%	2.6%	52.4%
Annual change in share of subprime mortgage originations at the MSA level (Δ*SUBPRIME*)	41.3%	124.7%	-87.1%	508.9%
Annual change in the quantity of purchase mortgage originations at the MSA level (Δ*ORIGINATIONS*)	10.5%	45.5%	-62.6%	182.8%
Number of mortgage brokers per 10,000 people (*BROKERS*)	6.05	6.38	0.02	42.75
Credit Risk				
MSA credit risk proxied by the annual purchase and refinancing mortgage application denial rates from HMDA (*CREDIT_RISK*)	20.1%	5.7%	8.2%	55.5%
Annual change in MSA credit risk (Δ*CREDIT_RISK*)	2.1%	25.2%	-63.1%	158.9%
Lease Characteristics				
Average annual rental default rate at the MSA level (*DEFAULT_INDEX*)	5.7%	5.2%	0.0%	29.2%
Average contracted gross rent at the MSA level (*RENT*)	$862	$362	$250	$5,000
Ratio of contracted gross rent to the MSA's fair market rent at lease origination (*RENT_LEVEL*)	1.15	0.40	0.27	7.25
Housing Market Conditions				
MSA house price indices (*HPI*)	158.1%	37.9%	106.0%	323.1%
Annual change in MSA house price indices (Δ*HPI*)	9.2%	7.3%	-0.2%	40.8%
MSA fair market rent (*FMR*)	$684	$175	$450	$1,382
Annual change in MSA fair market rent (Δ*FMR*)	3.7%	4.9%	-18.1%	31.4%
New building permits for multifamily units at the MSA level during the year (*SUPPLY_MF*)	2,120	2,909	0	16,570
Ratio of new of building permits for multifamily units to population at the MSA level (*SUPPLY*)	0.2%	0.2%	0.0%	1.4%
Quarterly MSA median house prices (*MED_HOUSE_PRICE*)	$184,659	$101,847	$75,000	$659,000
Average annual rental vacancy rates at the state level (*VACANCY*)	10.6%	2.9%	4.2%	18.1%
Local Demographic and Economic Conditions				
Monthly unemployment rate at the MSA level (*UNEMPLOYMENT*)	5.2%	1.6%	1.8%	14.1%
Change in monthly unemployment rate at the MSA level(Δ*UNEMPLOYMENT*)	0.6%	8.9%	-33.3%	62.0%
Change in per-capita annual income at the MSA level (Δ*INCOME*)	3.9%	2.9%	-10.2%	23.4%
Median annual household income at the MSA level (*MED_INCOME*)	$56,515	$10,197	$31,400	$105,500
Quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	60.6%	23.4%	2.6%	92.7%
Homeownship rate at the MSA level (*HOMEOWNSHIP*)	68.1%	4.7%	53.6%	79.6%
MSA population (*POPULATION*)	1,115,983	1,063,351	117,803	5,484,883
Annual change in MSA population (Δ_*POPULATION*)	1.5%	1.2%	-1.9%	4.8%
Proportion of the 20-34 year age group in the state population (*RENTERS*)	20.9%	1.4%	18.8%	25.8%

Table 4: Analysis of MSA Lease Default Indices

	Model (1)		*Model (2)*		*Model (3)*		*Model (4)*	
	Coefficient	*Std. Err.*	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*
Mortgage Market Conditions								
Lagged annual share of subprime mortgages to purchase mortgage originations at the MSA level (*SUBPRIME*)	0.0154***	*(0.0039)*	0.0138***	*(0.0038)*	0.0226***	*(0.0048)*	0.0202***	*(0.0053)*
Lagged annual change in share of subprime mortgage originations at the MSA level ($\Delta SUBPRIME$)	0.0021**	*(0.0009)*	0.0018**	*(0.0009)*	0.0017	*(0.0011)*	0.0006	*(0.0011)*
Lagged annual change in purchase mortgage originations at the MSA level ($\Delta ORIGINATIONS$)	0.0095***	*(0.0027)*	0.0095***	*(0.0027)*	0.0051*	*(0.0027)*	0.0078***	*(0.0028)*
Credit Risk								
Lagged MSA credit risk (*CREDIT_RISK*)			0.0166***	*(0.0062)*	0.0170**	*(0.0073)*	0.0289***	*(0.0092)*
Lagged annual change in MSA credit risk ($\Delta CREDIT\_RISK$)			0.0001	*(0.0011)*	-0.0010	*(0.0015)*	-0.0015	*(0.0017)*
Housing Market Conditions								
Low house price MSAs (*LOW_HOUSE_PRICE*)					0.0986**	*(0.0498)*	0.1170**	*(0.0498)*
High house price growth MSAs (*HIGH_PRICE_GROWTH*)					-0.0096	*(0.0539)*	-0.0703	*(0.0579)*
Lagged change in MSA house price indices (ΔHPI)					-0.0132	*(0.0123)*	-0.0206*	*(0.0125)*
Annual change in MSA fair market rent (ΔFMR)					0.0212***	*(0.0042)*	0.0238***	*(0.0042)*
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)					0.0207**	*(0.0103)*	0.0145	*(0.0113)*
Local Demographic and Economic Conditions								
Lagged MSA unemployment rate (*UNEMPLOYMENT*)							-0.0080	*(0.0247)*
Lagged change in MSA unemployment rate ($\Delta UNEMPLOYMENT$)							0.0005	*(0.0021)*
Lagged annual change in per-capita income at the MSA level ($\Delta INCOME$)							-0.0036	*(0.0087)*
High income household MSAs (*HIGH_INCOME*)							0.1657***	*(0.0465)*
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)							-0.0067***	*(0.0025)*
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)							-0.0745	*(0.1127)*
CONSTANT							*-4.1215**	*(2.4395)*
Year Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
N	2978		2978		2503		*2,482*	
Adj R-squared	0.273		0.274		0.245		*0.249*	

Note: This table reports ordinary least squares (OLS) regression results where the dependent variable is the logistic transformations of monthly MSA rental lease default indices. The dependent variable is *log(i/(1-i))* with i representing the average monthly lease default rate at the MSA level, where current leases are assigned a value of 0 and defaulted leases are coded as 1. The subprime variable(*SUBPRIME*) is measured using the number of purchase mortgages originated by subprime lenders according to the HUD subprime lender lists. The figures in parentheses are the robust standard errors, with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 5: Analysis of Individual Lease Defaults

	Model (1): PROBIT		*Model (2): Cox Prop. Hazard*	
	Marginal Eff.	Std. Err.	Hazard Ratio	Std. Err.
Mortgage Market Conditions				
Lagged annual share of subprime mortgages to purchase mortgage originations at the MSA level (*SUBPRIME*)	0.0030***	*(0.0003)*	1.0152***	*(0.0010)*
Lagged annual change in share of subprime mortgage originations at the MSA level ($\Delta SUBPRIME$)	0.0005***	*(0.0001)*	1.0004***	*(0.0002)*
Lagged annual change in purchase mortgage originations at the MSA level ($\Delta ORIGINATIONS$)	0.0018***	*(0.0002)*	1.0030***	*(0.0004)*
Credit Risk				
Lagged MSA credit risk (*CREDIT_RISK*)	0.0054***	*(0.0006)*	1.0173***	*(0.0016)*
Lagged annual change in MSA credit risk ($\Delta CREDIT\_RISK$)	0.0012***	*(0.0001)*	1.0032***	*(0.0003)*
Lease Characteristic				
Ratio of contracted rent to the MSA's fair market rent at lease origination (*RENT_LEVEL*)	-0.0010***	*(0.0000)*	0.9957***	*(0.0001)*
Housing Market Conditions				
Low house price MSAs (*LOW_HOUSE_PRICE*)	0.0365***	*(0.0039)*	1.1093***	*(0.0155)*
High house price growth MSAs (*HIGH_PRICE_GROWTH*)	-0.0023	*(0.0035)*	1.1365***	*(0.0158)*
Lagged change in MSA house price indices (ΔHPI)	0.0002	*(0.0002)*	0.9835***	*(0.0006)*
Annual change in MSA fair market rent (ΔFMR)	0.0006***	*(0.0002)*	1.0053***	*(0.0006)*
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)	0.0161***	*(0.0008)*	1.0661***	*(0.0027)*
Local Demographic and Economic Conditions				
Lagged MSA unemployment rate (*UNEMPLOYMENT*)	-0.0033**	*(0.0016)*	0.9933	*(0.0050)*
Lagged change in MSA unemployment rate ($\Delta UNEMPLOYMENT$)	0.0009***	*(0.0001)*	0.9996	*(0.0004)*
Lagged annual change in per-capita income at the MSA level ($\Delta INCOME$)	-0.0019***	*(0.0006)*	0.9915***	*(0.0019)*
High income household MSAs (*HIGH_INCOME*)	-0.0120***	*(0.0027)*	0.9512***	*(0.0086)*
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	-0.0002	*(0.0002)*	1.0057***	*(0.0004)*
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)	-0.0440***	(0.0056)	0.7869***	*(0.0141)*
CONSTANT				
Year Fixed Effects	*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*	
N	*424,340*		*424,336*	
Adj R-squared				
Wald chi-squared	*12,518*		*5,752*	

Note: Model (1) reports the marginal effects from the maximum likelihood estimate of the probit model of individual lease probability of default over 12 months. Model (2) reports the hazard ratios from the Cox proportional hazard estimation of the likelihood of lease default over 12 months from lease signing, assuming stratification at the MSA level. The subprime variable(*SUBPRIME*) is measured using the number of purchase mortgages originated by subprime lenders according to the HUD subprime lender lists. The time period of the analysis is from January 2002 to December 2006. The figures in parentheses are the robust standard errors, with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 6: Analysis of Lease Default for 2003 MSAs, 2003 Properties, and Rent Groups

	Model (1): 2003 MSAs		Model (2): 2003 Properties		Model (3): Rent Groups	
	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.
Mortgage Market Conditions						
Lagged annual share of subprime mortgages to purchase mortgage originations at the MSA level (*SUBPRIME*)	0.0033***	*(0.0003)*	0.0047***	*(0.0004)*	00030***	*(0.0003)*
Lagged change in subprime mortgage originations at the MSA level (Δ*SUBPRIME*)	0.0005***	*(0.0001)*	0.0003***	*(0.0001)*		
Lagged annual change in subprime originations interacted with low gross rent quartile dummy (Δ*SUBPRIME*RENT1*)					0.0004***	*(0.0001)*
Lagged annual change in subprime originations interacted with 2nd gross rent quartile dummy over that of 1st rent quartile dummy (Δ*SUBPRIME*RENT2*)					0.0003***	*(0.0001)*
Lagged annual change in subprime originations interacted with 3rd gross rent quartile dummy over that of 1st rent quartile dummy (Δ*SUBPRIME*RENT3*)					0.0005***	*(0.0001)*
Lagged annual change in subprime originations interacted with high gross rent quartile dummy over that of 1st rent quartile dummy (Δ*SUBPRIME*RENT4*)					0.0003***	*(0.0001)*
Lagged annual change in purchase mortgage originations at the MSA level (Δ*ORIGINATIONS*)	0.0024***	*(0.0002)*	0.0027***	*(0.0002)*	0.0020***	*(0.0002)*
Credit Risk						
Lagged MSA credit risk (*CREDIT_RISK*)	0.0061***	*(0.0007)*	0.0065***	*(0.0008)*	0.0077***	*(0.0006)*
Lagged annual change in MSA credit risk (Δ*CREDIT_RISK*)	0.0010***	*(0.0001)*	0.0010***	*(0.0001)*	0.0009***	*(0.0001)*
Lease Characteristic						
Ratio of contracted rent to the MSA's fair market rent at lease origination (*RENT_LEVEL*)	-0.0011***	*(0.0000)*	-0.0013***	*(0.0000)*	-0.0010***	*(0.0000)*
Housing Market Conditions						
Low house price MSAs (*LOW_HOUSE_PRICE*)	0.0331***	*(0.0040)*	0.0413***	*(0.0045)*	0.0351***	*(0.0038)*
High house price growth MSAs (*HIGH_PRICE_GROWTH*)	0.0119***	*(0.0035)*	0.0275***	*(0.0040)*	0.0116***	*(0.0035)*
Lagged annual change in MSA house price indices (Δ*HPI*)	-0.0104***	*(0.0005)*	-0.0049***	*(0.0007)*	-0.0106***	*(0.0005)*
Annual change in MSA fair market rent (Δ*FMR*)	0.0011***	*(0.0002)*	0.0018***	*(0.0002)*	0.0004**	*(0.0002)*
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)	0.0162***	*(0.0008)*	0.0154***	*(0.0010)*	0.0164***	*(0.0008)*
Local Demographic and Economic Conditions						
Lagged MSA annual unemployment rate (*UNEMPLOYMENT*)	0.0098***	*(0.0016)*	0.0073***	*(0.0018)*	-0.0040***	*(0.0016)*
Lagged annual change in MSA unemployment rate (Δ*UNEMPLOYMENT*)	-0.0011***	*(0.0001)*	-0.0003**	*(0.0001)*	0.0007***	*(0.0001)*
Lagged annual change in per-capita annual income at the MSA level (Δ*INCOME*)	-0.0022***	*(0.0006)*	-0.0005	*(0.0007)*	-0.0010*	*(0.0006)*
High income household MSAs (*HIGH_INCOME*)	-0.0104***	*(0.0027)*	-0.0012	*(0.0034)*	-0.0167***	*(0.0026)*
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	-0.0011***	*(0.0002)*	-0.0008***	*(0.0002)*	-0.0007***	*(0.0001)*
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)	-0.0589***	*(0.0052)*	-0.0442***	*(0.0060)*	-0.0548***	*(0.0056)*
Year Fixed Effects	*Yes*		*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*		*Yes*	
N	*403,888*		*280673*		*424,340*	
Wald chi-squared	*12,815*		*11,423*		*13,094*	

Note: This table reports the marginal effects from probit estimations of the probability of residential lease default during the first 12 months restricted to MSAs and properties present in dataset in 2003. The subprime variable(*SUBPRIME*) is measured using the number of purchase mortgages originated by subprime lenders according to the HUD subprime lender lists. The figures in parentheses are the robust standard errors, with the 1, 2 and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 7: Probit Estimation of Marginal Effects of Lease Default Over 12 Months with Subprime Mortgages Identified Using HUD Subprime Lender Lists and HMDA High-Price Mortgages

	SUBPRIME: HUD Subprime Lender Lists				SUBPRIME: HMDA High-Price Mortgages			
	Number		Dollar Vol.		Number		Dollar Vol.	
	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.	Marginal Effect	Std. Err.
Mortgage Market Conditions								
Lagged annual share of subprime mortgages to purchase mortgage originations at the MSA level (*SUBPRIME*)	0.0030***	*(0.0003)*	0.0052***	(0.0004)	0.0009***	(0.0002)	0.0011***	(0.0003)
Lagged annual change in share of subprime mortgage originations at the MSA level ($\Delta SUBPRIME$)	0.0005***	*(0.0001)*	0.0003***	(0.0001)	0.0006***	(0.0001)	0.0005***	(0.0001)
Lagged annual change in purchase mortgage originations at the MSA level ($\Delta ORIGINATIONS$)	0.0018***	*(0.0002)*	0.0016***	(0.0002)	0.0016***	(0.0002)	0.0015***	(0.0002)
Credit Risk								
Lagged MSA credit risk (*CREDIT_RISK*)	0.0054***	*(0.0006)*	0.0048***	(0.0006)	0.0071***	(0.0006)	0.0074***	(0.0006)
Lagged annual change in MSA credit risk ($\Delta CREDIT\_RISK$)	0.0012***	*(0.0001)*	0.0012***	(0.0001)	0.0011***	(0.0001)	0.0011***	(0.0001)
Lease Characteristic								
Ratio of contracted rent to the MSA's fair market rent at lease origination (*RENT_LEVEL*)	-0.0010***	*(0.0000)*	-0.0010***	(0.0000)	-0.0010***	(0.0000)	-0.0010***	(0.0002)
Housing Market Conditions								
Low house price MSAs (*LOW_HOUSE_PRICE*)	0.0365***	*(0.0039)*	0.0348***	(0.0039)	0.0320***	(0.0039)	0.0292***	(0.0038)
High house price growth MSAs (*HIGH_PRICE_GROWTH*)	-0.0023	*(0.0035)*	-0.0008	(0.0035)	-0.0041	(0.0035)	-0.0030	(0.0034)
Lagged annual change in MSA house price indices (ΔHPI)	0.0002	*(0.0002)*	-0.0013***	(0.0002)	0.0006***	(0.0002)	-0.0008***	(0.0002)
Annual change in MSA fair market rent (ΔFMR)	0.0006***	*(0.0002)*	0.0005***	(0.0002)	0.0003**	(0.0002)	0.0003*	(0.0002)
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)	0.0161***	*(0.0008)*	0.0174***	(0.0008)	0.0147***	(0.0008)	0.0155***	(0.0008)
Local Demographic and Economic Conditions								
Lagged MSA annual unemployment rate (*UNEMPLOYMENT*)	-0.0033**	*(0.0016)*	-0.0057***	(0.0016)	-0.0012	(0.0015)	-0.0011	(0.0015)
Lagged annual change in MSA unemployment rate ($\Delta UNEMPLOYMENT$)	0.0009***	*(0.0001)*	0.0010***	(0.0001)	0.0008***	(0.0001)	0.0007***	(0.0001)
Lagged annual change in per-capita annual income at the MSA level ($\Delta INCOME$)	-0.0019***	*(0.0006)*	-0.0011**	(0.0006)	-0.0026***	(0.0006)	-0.0024***	(0.0006)
High income household MSAs (*HIGH_INCOME*)	-0.0120***	*(0.0027)*	-0.0131***	(0.0027)	-0.0095***	(0.0027)	-0.0094***	(0.0027)
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	-0.0002	*(0.0002)*	0.00004	(0.0002)	-0.0004***	(0.0002)	-0.0004**	(0.0002)
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)	-0.0440***	*(0.0056)*	-0.0473***	(0.0057)	-0.0513***	(0.0055)	-0.0574***	(0.0057)
Year Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
N	*424,340*		*424,340*		*424,340*		*424,340*	
Wald chi-squared	*12,518*		*12,714*		*12,416*		*12,486*	

Note: This table reports the marginal effects from probit estimations of the probability of residential lease default during the first 12 months. Subprime mortgages are identified using HUD subprime lender lists and alternatively using the HMDA high-price mortgage flag. For each of these two alternative subprime identifiers, the subprime variable (*SUBPRIME*) is then measured using the number and the dollar volume of mortgage originations in columns *(1)* and *(2)*, respectively. The figures in parentheses are the robust standard errors, with the 1, 2 and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 8: OLS Regressions of Monthly MSA Lease Default Indices on Homeownership Rates

	Model (1): 2001-2006		Model (1): 2001-2009	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Mortgage Market Conditions				
Lagged homeownship rate at the MSA level (*HOMOWN*)	0.035***	(0.009)	0.032***	(0.007)
Lagged homeownship rate times post-2006 dummy (*HOMOWN*POST2006*)			-0.029***	(0.008)
Credit Risk				
Lagged MSA credit risk (*CREDIT_RISK*)	0.033*	(0.017)	0.053***	(0.010)
Lagged annual change in MSA credit risk (Δ*CREDIT_RISK*)	-0.006**	(0.003)	-0.007***	(0.002)
Housing Market Conditions				
Low house price MSAs (*LOW_HOUSE_PRICE*)	0.193**	(0.098)	0.123**	(0.060)
High house price growth MSAs (*HIGH_PRICE_GROWTH*)	0.045	(0.081)	0.131***	(0.047)
Lagged quarterly change in MSA house price indices (Δ*HPI*)	-0.044*	(0.025)	-0.053***	(0.013)
Annual change in MSA fair market rent (Δ*FMR*)	0.014***	(0.005)	0.008**	(0.004)
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)	0.290***	(0.066)	0.097*	(0.051)
Local Demographic and Economic Conditions				
Lagged monthly MSA unemployment rate (*UNEMPLOYMENT*)	0.083	(0.057)	-0.035	(0.031)
Lagged monthly change in MSA unemployment rate (Δ*UNEMPLOYMENT*)	0.000	(0.003)	0.003	(0.002)
Lagged annual change in per-capita income at the MSA level (Δ*INCOME*)	-0.020	(0.021)	-0.032**	(0.014)
High income household MSAs (*HIGH_INCOME*)	0.204**	(0.088)	0.057	(0.054)
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	-0.001	(0.005)	0.003	(0.002)
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)	-0.206	(0.155)	-0.204**	(0.092)
CONSTANT	-3.385	(3.346)	-3.313	(2.117)
Year Fixed Effects	*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*	
N	1426		2559	
Adj R-squared	0.343		0.310	

Note: This table reports OLS regression results of logistic transformations of monthly MSA rental lease default indices on homeownership rates. The dependent variable is *log(i/(1-i))* with i representing the average monthly lease default rate at the MSA level, where current leases are assigned a value of 0 and defaulted leases are coded as 1. The figures in parentheses are the robust standard errors, with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 9: Alternative Analysis of MSA and Individual Lease Defaults Using Instrumental Variables (IV) Approach

	Model (1): MSA Default Indices				Model (2): Individual Lease Default			
	1st-Stage IV		*2nd Stage IV*		*1st Stage IV*		*IV PROBIT*	
	Coefficient	*Std. Err.*	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*	*Marginal Effect*	*Std. Err.*
Mortgage Market Conditions								
Lagged annual share of subprime mortgages to purchase mortgage originations at the MSA level (*SUBPRIME*)			0.0348***	*(0.0123)*			0.0048***	*(0.0004)*
Lagged annual change in share of subprime mortgage originations at the MSA level (Δ*SUBPRIME*)	0.0249***	*(0.0043)*	0.0004	*(0.0011)*	0.0212***	*(0.0004)*	0.0004***	*(0.0001)*
Lagged annual change in purchase mortgage originations at the MSA level (Δ*ORIGINATIONS*)	-0.0244*	*(0.0139)*	0.0077***	*(0.0028)*	-0.1344***	*(0.0013)*	0.0019***	*(0.0002)*
Credit Risk								
Lagged MSA credit risk (*CREDIT_RISK*)	0.4201***	*(0.0425)*	0.0189*	*(0.0111)*	0.6352***	*(0.0041)*	0.0039***	*(0.0007)*
Lagged annual change in MSA credit risk (Δ*CREDIT_RISK*)	0.0063	*(0.0068)*	-0.0006	*(0.0018)*	-0.0178***	*(0.0005)*	0.0013***	*(0.0001)*
Lease Characteristic								
Ratio of contracted rent to the MSA's fair market rent at lease origination (*RENT_LEVEL*)					-0.0004***	*(0.0001)*	-0.0010***	*(0.0000)*
Housing Market Conditions								
Low house price MSAs (*LOW_HOUSE_PRICE*)	0.0495	*(0.2191)*	0.1234**	*(0.0493)*	-1.0301***	*(0.0233)*	0.0396***	*(0.0040)*
High house price growth MSAs (*HIGH_PRICE_GROWTH*)	-1.2358***	*(0.2804)*	-0.0654	*(0.0577)*	-1.4098***	*(0.0225)*	-0.0007	*(0.0035)*
Lagged change in MSA house price indices (Δ*HPI*)	-0.2179***	*(0.0528)*	-0.0176	*(0.0131)*	-0.0265***	*(0.0010)*	-0.0000	*(0.0002)*
Annual change in MSA fair market rent (Δ*FMR*)	-0.1600***	*(0.0118)*	0.0260***	*(0.0050)*	-0.1311***	*(0.0007)*	0.0007***	*(0.0002)*
Lagged ratio of new multifamily building permits to population at the MSA level (*SUPPLY*)	-0.8870***	*(0.0595)*	0.0232	*(0.0146)*	-0.4862***	*(0.0057)*	0.0171***	*(0.0008)*
Local Demographic and Economic Conditions								
Lagged MSA unemployment rate (*UNEMPLOYMENT*)	-0.3970***	*(0.1010)*	-0.0011	*(0.0242)*	0.2262***	*(0.0104)*	-0.0048***	*(0.0016)*
Lagged change in MSA unemployment rate (Δ*UNEMPLOYMENT*)	0.0077	*(0.0100)*	0.0003	*(0.0021)*	-0.0598***	*(0.0010)*	0.0010***	*(0.0001)*
Lagged annual change in per-capita income at the MSA level (Δ*INCOME*)	-0.1824***	*(0.0307)*	0.0001	*(0.0091)*	-0.1167***	*(0.0035)*	-0.0013**	*(0.0006)*
High income household MSAs (*HIGH_INCOME*)	0.9461***	*(0.2340)*	0.1491***	*(0.0493)*	1.5674***	*(0.0161)*	-0.0146***	*(0.0027)*
Lagged quarterly NAHB/Well Fargo housing opportunity index at the MSA level (*HOI*)	-0.1160***	*(0.0110)*	-0.0041	*(0.0033)*	-0.0667***	*(0.0008)*	0.0001	*(0.0002)*
Lagged proportion of the 20-34 year age group in the state population (*RENTERS*)	0.8368*	*(0.4843)*	-0.0986	*(0.1163)*	-2.5499***	*(0.0394)*	-0.0395***	*(0.0056)*
Instrumental Variable								
Number of mortgage brokers (*BROKERS*)	5.8397***	*(0.1905)*			5.3692***	*(0.0139)*		
CONSTANT	*5.2740*	*(9.8668)*	*-3.9159*	*(2.4580)*	*62.0854****	*(0.8316)*		
Year Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
State Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
N	*2,482*		*2,482*		*424,340*		*424,340*	
Adj R-squared	0.711		*0.246*					
Wald chi-squared			*1,104*		*27.6*		*12,542*	

Note: Model (1) reports second stage 2SLS IV regression results where the dependent variable is the logistic transformations of monthly MSA rental lease default indices. The dependent variable is *log(i/(1-i))* with *i* representing the average monthly lease default rate at the MSA level, where current leases are assigned a value of 0 and defaulted leases are coded as 1. The model is estimated in an instrumental variables framework where the number of mortgage brokers is used as an instrumental variable for the subprime variable (*SUBPRIME*). Model (2) reports the marginal effects from the probit model of individual lease probability of default over 12 months. The probit model is estimated in an instrumental variables framework with the number of mortgage brokers as an instrumental variable for *SUBPRIME*. The time period of the analysis is from January 2002 to December 2006. The subprime variable is measured using the number of purchase mortgages originated by subprime lenders according to the HUD subprime lender lists. The time period of the analysis is from January 2002 to December 2006. The figures in parentheses are the robust standard errors, with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 10: Estimated Potential Rental Income Losses in Low and High Subprime MSAs

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*Average*
Potential losses defined as late payments									
Low-subprime MSAs	1.28	3.64	4.69	4.35	3.63	4.35	5.47	5.84	4.15
	(6.07)	*(13.00)*	*(23.31)*	*(30.16)*	*(34.99)*	*(48.19)*	*(58.92)*	*(66.36)*	
High-subprime MSAs	4.89	5.36	5.53	6.16	4.80	5.64	7.03	6.62	5.75
	(25.76)	*(35.53)*	*(53.29)*	*(68.67)*	*(87.15)*	*(114.00)*	*(141.35)*	*(154.40)*	
High-Low	3.61	1.72	0.85	1.81	1.17	1.29	1.56	0.78	38.50%
	(12.72)	*(5.41)*	*(3.75)*	*(10.68)*	*(9.97)*	*(12.57)*	*(14.82)*	*(7.96)*	
Potential losses defined as late and unfunded-check payments									
Low-subprime MSAs	1.40	4.02	5.14	4.86	4.13	4.93	6.23	6.66	4.67
	(6.24)	*(13.34)*	*(23.47)*	*(30.69)*	*(35.92)*	*(49.79)*	*(61.14)*	*(68.66)*	
High-subprime MSAs	5.67	6.13	6.13	6.77	5.38	6.42	7.93	7.43	6.48
	(27.17)	*(36.54)*	*(55.40)*	*(71.03)*	*(90.29)*	*(118.33)*	*(145.76)*	*(159.84)*	
High-Low	4.28	2.11	0.99	1.91	1.26	1.49	1.70	0.77	38.83%
	(13.97)	*(6.12)*	*(4.04)*	*(10.34)*	*(9.71)*	*(13.15)*	*(14.72)*	*(7.20)*	
Num. Observations									
Low-subprime MSAs	*355*	*911*	*2,585*	*4,550*	*8,065*	*13,440*	*17,311*	*22,750*	
High-subprime MSAs	*3,530*	*5,325*	*15,391*	*22,553*	*44,444*	*63,456*	*83,299*	*111,079*	

Note: This table presents average annual potential rental income losses (in percents) in low and high subprime MSAs. MSAs are classified into quartiles according to the percentage of purchase subprime mortgage originations in the area from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are areas in the 4th quartile. The percentage of potential rental income losses is defined at the lease level as the ratio of late rent payments and unfunded checks during the year. The *High-Low* rows present the tests of difference in mean average losses between the two subgroups. The figures in parentheses are the t-statistics of the above average income loss estimates.

Table 11: The Effect of Rental Default on Rent Level from 2001 to 2007

	(1) Whole Sample		(2) Low Rent Tercile		(3) Middle Rent Tercile		(4) High Rent Tercile	
	Coefficient	*Std. Err.*	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*	*Coefficient*	*Std. Err.*
Panel A: Regression of monthly average RENT at the MSA level								
Lagged average contracted gross rent at the MSA level ($R_{i,t-1}$)	0.629***	*(0.065)*	0.648***	*(0.025)*	0.482***	*(0.132)*	0.354***	*(0.082)*
Lagged average monthly lease default rate at the MSA level ($RISK_{i,t-1}$)	0.985***	*(0.194)*	0.388***	*(0.096)*	1.218***	*(0.277)*	2.440***	*(0.409)*
Lagged average annual rental vacancy rates at the state level ($VACANCY_{i,t-1}$)	-1.537***	*(0.420)*	-2.008***	*(0.323)*	-2.269***	*(0.645)*	-2.322***	*(0.807)*
CONSTANT	185.554***	*(33.171)*	211.650***	*(15.719)*	344.241***	*(87.868)*	494.073***	*(64.161)*
MSA Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
RENT-TERCILE Fixed Effects	*Yes*							
N	*26,221*		*8,762*		*8,825*		*8,634*	
Adj. R-squared	*0.911*		*0.941*		*0.961*		*0.896*	
Panel B: Regression of monthly average RENT at the property level								
Lagged average contracted gross rent at the property level ($R_{i,t-1}$)	-0.019	(0.017)	0.110***	(0.014)	0.093***	(0.035)	0.937***	(0.045)
Lagged average monthly lease default rate at the property level ($RISK_{i,t-1}$)	2.045***	(0.168)	0.928***	(0.140)	1.779***	(0.168)	1.010**	(0.395)
Residuals from regression of MSA $RISK_{i,t-1}$ on property $RISK_{i,t-1}$ (*RESID*)	3.423***	(0.345)	0.729**	(0.287)	1.805***	(0.445)	3.761***	(0.629)
Lagged average annual rental vacancy rates at the state level ($VACANCY_{i,t-1}$)	-4.253***	(0.613)	-5.122***	(0.678)	-3.155***	(0.615)	-2.350*	(1.207)
CONSTANT	524.962***	(18.991)	570.295***	(13.757)	597.225***	(24.588)	135.648***	(34.976)
MSA Fixed Effects	*Yes*		*Yes*		*Yes*		*Yes*	
RENT-TERCILE Fixed Effects	*Yes*							
N	*20,637*		*4,983*		*9,281*		*6,373*	
Adj. R-squared	*0.761*		*0.900*		*0.825*		*0.884*	

Note: This table shows the OLS estimations of average rent at the MSA level (Panel A) and at the property level (Panel B) on corresponding average monthly lease defaults from 2001 to 2007. The columns labeled 'Std. Err.' report the robust standard errors of the coefficient estimates, with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 12: MSA Panel Regressions of NCREIF Multifamily Property Index Returns on Rental Default Indices

Dependent Variable	(1) Income Return	(2) Income Return	(3) Total Return	(4) Total Return
DEF_INDEX1	-0.0159***		0.0533	
	(-4.73)		*(1.44)*	
DEF_INDEX2		-0.0136***		0.0447
		(-5.10)		*(1.49)*
constant	1.623***	1.624***	2.667***	2.673***
	(92.91)	*(100.19)*	*(13.80)*	*(14.63)*
MSA Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
N	*625*	*625*	*625*	*625*
adj. R^2	*0.099*	*0.099*	*0.006*	*0.006*

Note: These coefficient estimates are from MSA fixed-effect panel regressions of quarterly income returns (*Inc. Return*) and total returns (*Tot. Return*) on the NCREIF multifamily property index on rental default indices based on RentBureau residential rental data over the period from 2001 to 2006. The rental default index *DEF_INDEX_1* classifies on-time rent payments as zero and all payment delinquencies as one. *DEF_INDEX_2*, on the other hand, is a similarly computed quarterly MSA rental default index that classifies rent payment delinquencies as less severe (one) or severe (two), as explained in section 7. The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 13: MSA Panel Regressions of of Cap Rate Spreads on Multifamily Property Transactions on Rental Default Indices

Dependent Variable	*(1) Cap Rate Spread*	*(2) Cap Rate Spread*
DEF_INDEX1	0.0206*	
	(1.78)	
DEF_INDEX2		0.0187*
		(1.87)
TERM	1.412***	1.412***
	(48.05)	*(47.87)*
MORTG_PREM	2.728***	2.735***
	(15.70)	*(15.74)*
constant	-2.932***	-2.950***
	(-8.25)	*(-8.24)*
N	*623*	*623*
Wald χ^2	*2,883*	*2,845*

Note: These coefficient estimates are from MSA random-effect panel regressions of average quarterly MSA transaction capitalization rate (cap rate) spreads over the risk-free rate on multifamily rental default indices over the period from 2001 to 2006. Transaction cap rates are from Real Capital Analytics, with the risk-free rate proxied by the 3-month TBill rate. Rental performance data are from RentBureau. The rental default index *DEF_INDEX_1* classifies on-time rent payments as zero and all payment delinquencies as one. *DEF_INDEX_2*, on the other hand, is a similarly computed quarterly MSA rental default index that classifies rent payment delinquencies as less severe (one) or severe (two), as explained in section 7. *TERM*, the interest rate term structure, is the difference between the 10-year TBond rate and the 3-month Treasury bill rate. *MORTG_PREM* is the premium of the 30-yr FRM rate over the 10-year Treasury rate. The interest rate and mortgage rate data are from the Federal Reserve Bank of St. Louis. The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

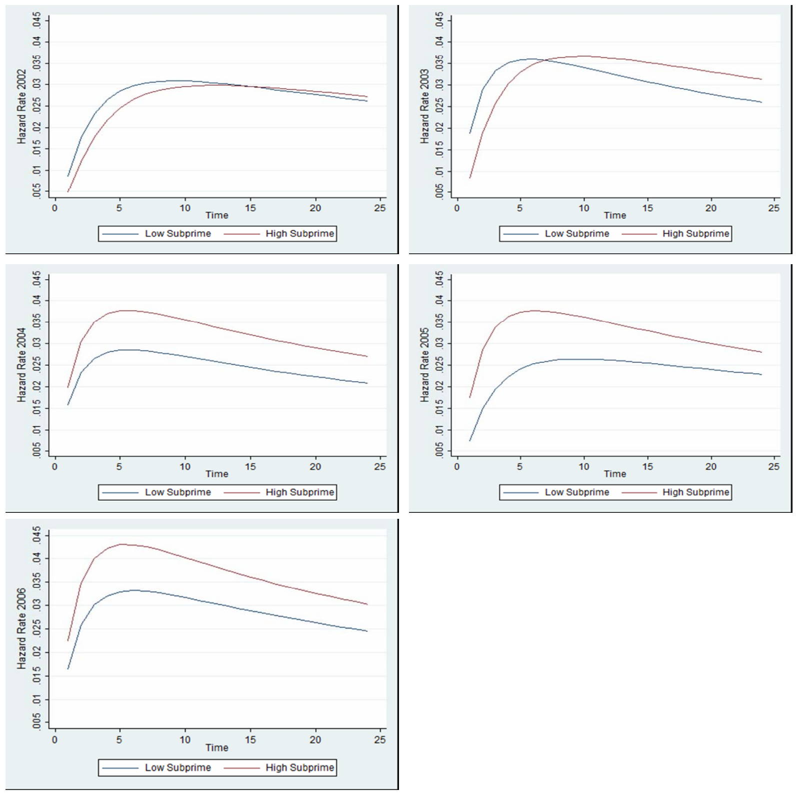

Figure 1: **Lease Hazard Curves in Low and High Subprime MSAs from 2002 to 2006, assuming a lognormal distribution.** (MSAs are classified according to the percentage of purchase subprime mortgages originations from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are those in the 4th quartile.)

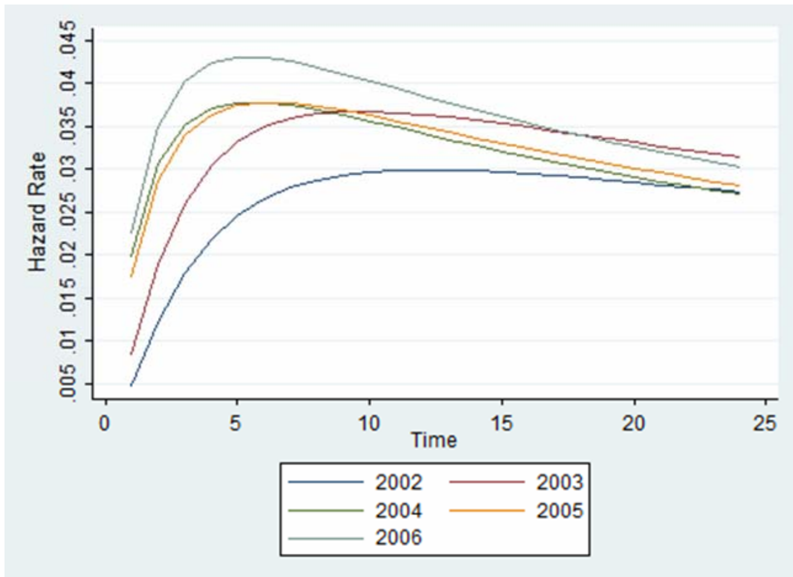

Figure 2: **Evolution of Lease Hazard Curves in High Subprime MSAs, Assuming a Lognormal Distribution.** (MSAs are classified according to the percentage of purchase subprime mortgages originations from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are those in the 4th quartile.)

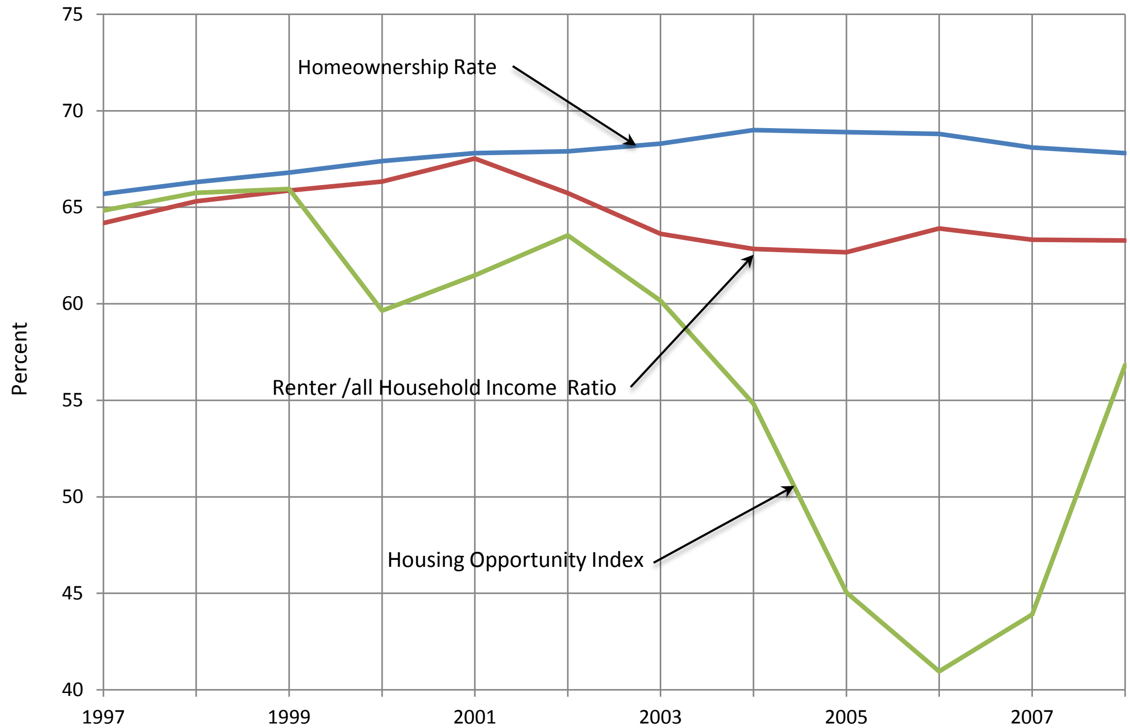

Figure 3: **Homeownership Rates, Median Renter Income/All Household Income Ratio, and Housing Opportunity Index**
(Source: U.S. Census Bureau and the National Association of Home Builders (NAHB))

Figure 4: **Seasonally Adjusted Monthly Unemployment Rates**
(Source: Bureau of Labor Statistics)

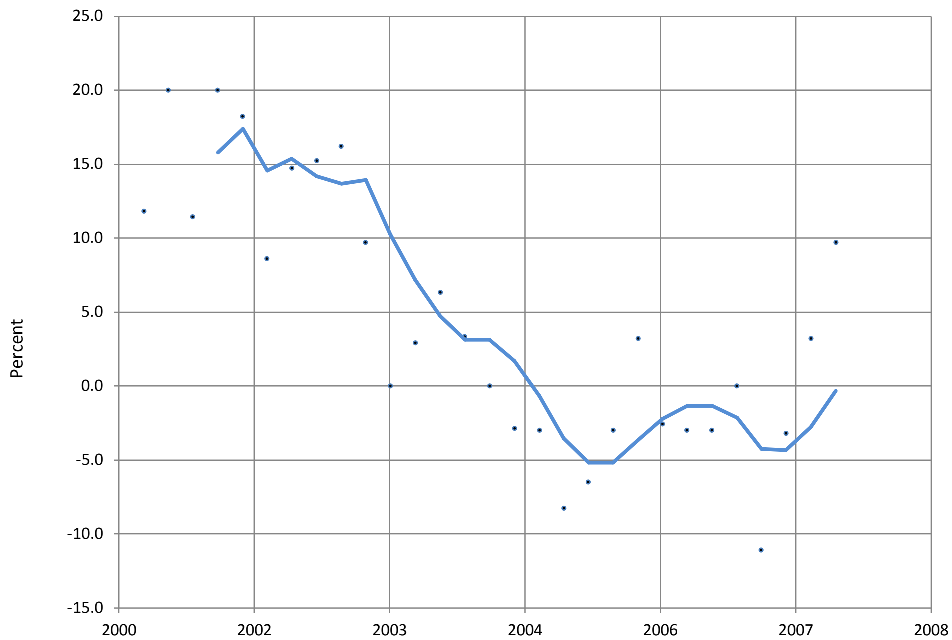

Figure 5: **4-quarter Moving Average of Net Percentage of Domestic Respondents Tightening Standards on Consumer Loans, Credit Cards (DRTSCLCC)**
(Source: Board of Governors of the Federal Reserve System)

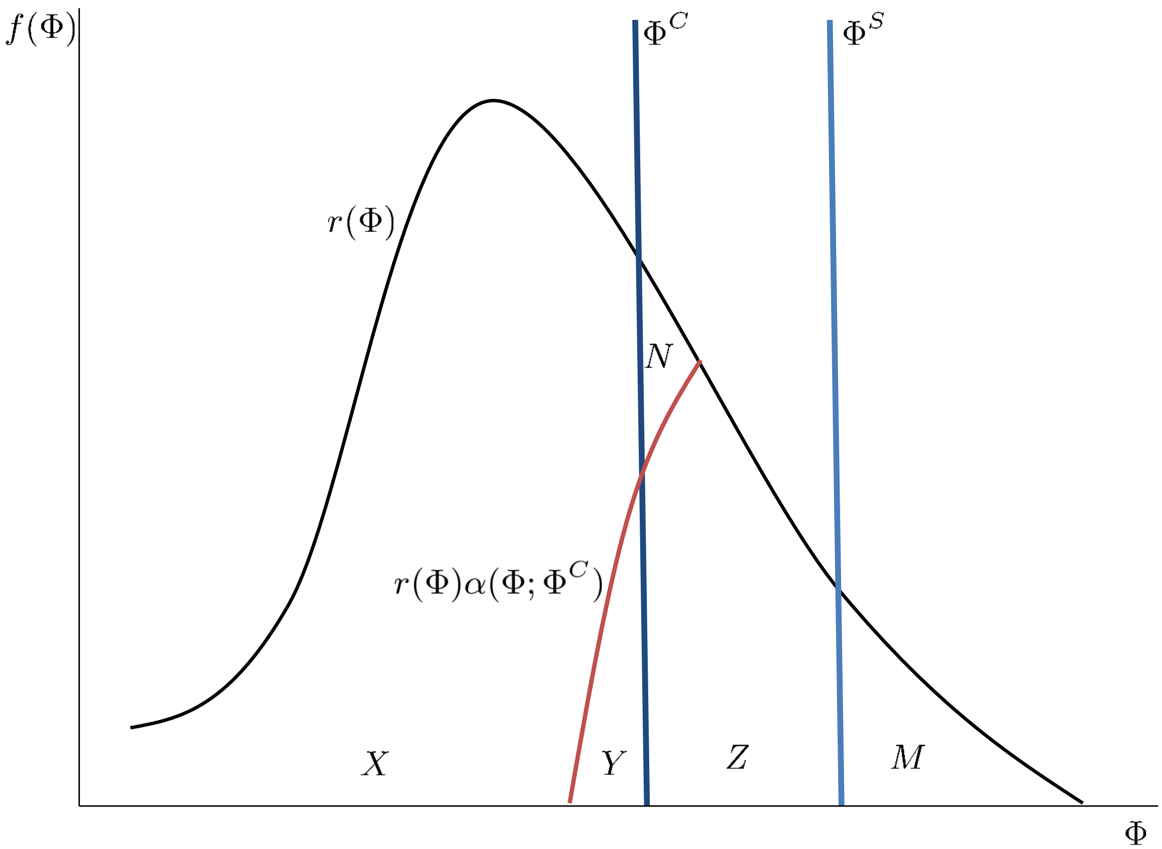

Figure 6: **The Distribution of Conventional, Subprime, and Rental Households**
Note: $r(\Phi)$ = marginal probability density function of the household credit risk; $\alpha(\Phi;\Phi^C)$ =share of households with credit risk Φ that apply for subprime mortgages given conventional underwriting standards (Φ^C). Φ^S = the subprime underwriting standards; N = conventional rejections (low-risk renters); M = subprime rejections (high-risk renters); X = conventional mortgage originations; $Y + Z$ = subprime mortgage originations; $N + M$ = the rental market.

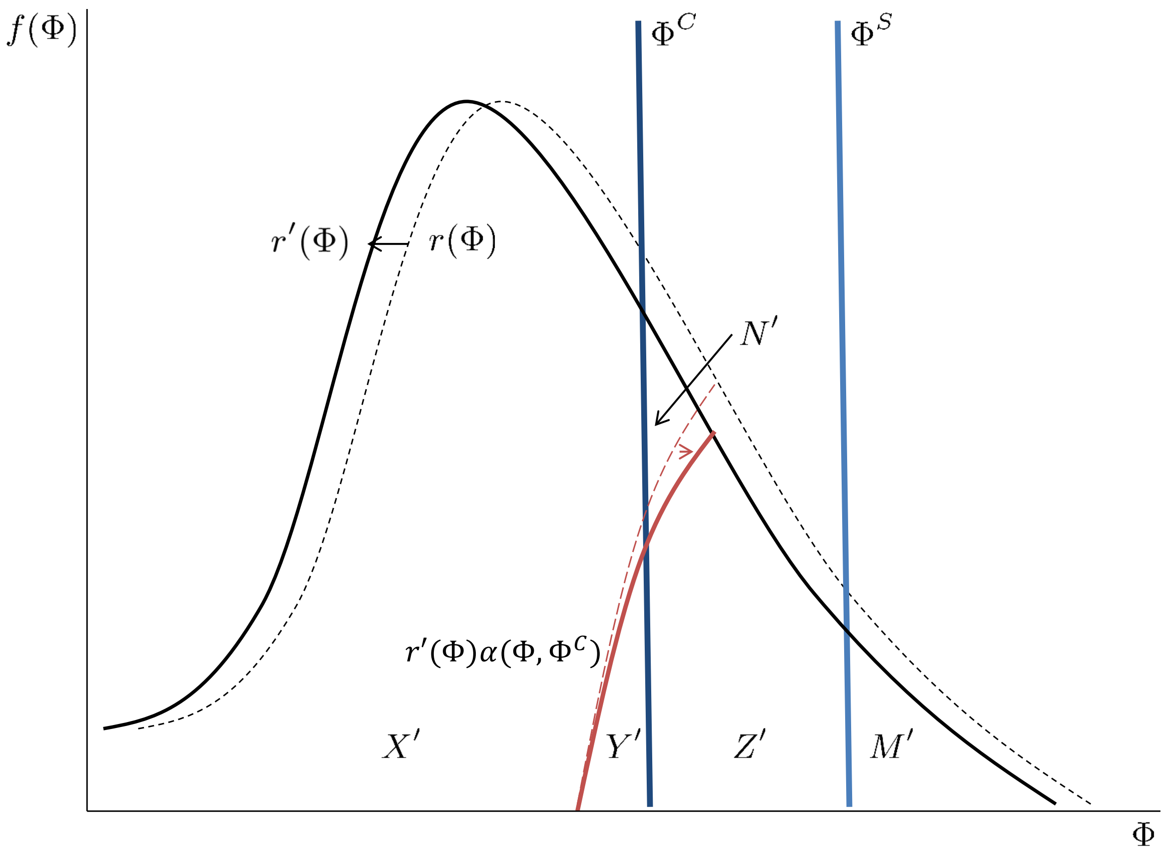

Figure 7: **The Impact of a Decrease in Household Credit Risk**

Note: $r(\Phi)$ = marginal probability density function of the household credit risk; $\alpha(\Phi; \Phi^C)$ =share of households with credit risk Φ that apply for subprime mortgages given conventional underwriting standards (Φ^C). Φ^S = the subprime underwriting standards; N' = conventional rejections (low-risk renters); M' = subprime rejections (high-risk renters); X' = conventional mortgage originations; $Y' + Z'$ = subprime mortgage originations; $N' + M'$ = the rental market.

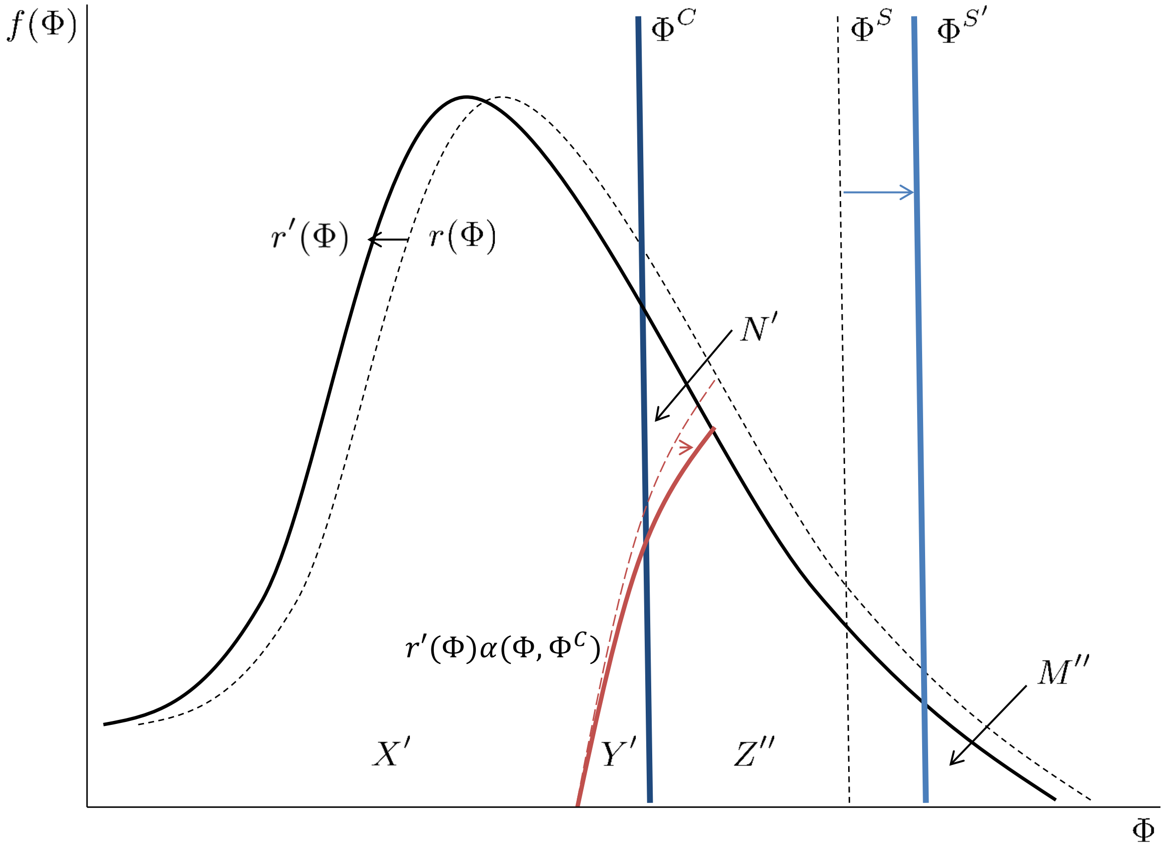

Figure 8: **The Impact of a Decrease in Household Credit Risk and a Relaxation in Subprime Lending Standards**

Note: $r(\Phi)$ = marginal probability density function of the household credit risk; $\alpha(\Phi; \Phi^C)$ =share of households with credit risk Φ that apply for subprime mortgages given conventional underwriting standards (Φ^C); Φ^S = the subprime underwriting standards; N' = conventional rejections (low-risk renters); M'' = subprime rejections (high-risk renters); X' = conventional mortgage originations; $Y' + Z''$ = subprime mortgage originations; $N' + M''$ = the rental market.

Appendix:

Table A.1: 2002 MSAs

Obs.	*FIPS*	*MSA Name*	*State*
1	11700	Asheville	NC
2	12060	Atlanta-Sandy Springs-Marietta	GA
3	13140	Beaumont-Port Arthur	TX
4	16580	Champaign-Urbana	IL
5	16700	Charleston-North Charleston-Summerville	SC
6	16740	Charlotte-Gastonia-Rock Hill	NC
7	17140	Cincinnati-Middletown	OH
8	17900	Columbia	SC
9	19380	Dayton	OH
10	19660	Deltona-Daytona Beach-Ormond Beach	FL
11	19740	Denver-Aurora-Broomfield	CO
12	23540	Gainesville	FL
13	24860	Greenville-Mauldin-Easley	SC
14	26420	Houston-Sugar Land-Baytown	TX
15	26900	Indianapolis-Carmel	IN
16	27260	Jacksonville	FL
17	28140	Kansas City	MO
18	28940	Knoxville	TN
19	29460	Lakeland-Winter Haven	FL
20	29620	Lansing-East Lansing	MI
21	29820	Las Vegas-Paradise	NV
22	32820	Memphis	TN
23	33460	Minneapolis-St. Paul-Bloomington	MN
24	34940	Naples-Marco Island	FL
25	34980	Nashville-DavidsonMurfreesboroFranklin	TN
26	36100	Ocala	FL
27	36420	Oklahoma City	OK
28	36740	Orlando-Kissimmee-Sanford	FL
29	37860	Pensacola-Ferry Pass-Brent	FL
30	38060	Phoenix-Mesa-Glendale	AZ
31	39580	Raleigh-Cary	NC
32	40900	SacramentoArden-ArcadeRoseville	CA
33	40980	Saginaw-Saginaw Township North	MI
34	41700	San Antonio-New Braunfels	TX
35	41940	San Jose-Sunnyvale-Santa Clara	CA
36	43780	South Bend-Mishawaka	IN
37	44700	Stockton	CA
38	45220	Tallahassee	FL
39	45300	Tampa-St. Petersburg-Clearwater	FL
40	45780	Toledo	OH
41	46060	Tucson	AZ
42	46140	Tulsa	OK
43	49700	Yuba City	CA

Table A.2: MSA List

No.	*FIPS*	*MSA Name*	*State*
1	11460	Ann Arbor	MI
2	11700	Asheville	NC
3	12060	Atlanta-Sandy Springs-Marietta	GA
4	12580	Baltimore-Towson	MD
5	13140	Beaumont-Port Arthur	TX
6	13380	Bellingham	WA
7	13820	Birmingham-Hoover	AL
8	14260	Boise City-Nampa	ID
9	14500	Boulder	CO
10	15180	Brownsville-Harlingen	TX
11	16580	Champaign-Urbana	IL
12	16700	Charleston-North Charleston-Summerville	SC
13	16740	Charlotte-Gastonia-Rock Hill	NC
14	17140	Cincinnati-Middletown	OH
15	17460	Cleveland-Elyria-Mentor	OH
16	17820	Colorado Springs	CO
17	17900	Columbia	SC
18	18140	Columbus	OH
19	19380	Dayton	OH
20	19660	Deltona-Daytona Beach-Ormond Beach	FL
21	19740	Denver-Aurora-Broomfield	CO
22	21340	El Paso	TX
23	22180	Fayetteville	NC
24	22380	Flagstaff	AZ
25	23540	Gainesville	FL
26	24660	Greensboro-High Point	NC
27	24860	Greenville-Mauldin-Easley	SC
28	26420	Houston-Sugar Land-Baytown	TX
29	26900	Indianapolis-Carmel	IN
30	27260	Jacksonville	FL
31	28020	Kalamazoo-Portage	MI
32	28140	Kansas City	MO
33	28940	Knoxville	TN
34	29460	Lakeland-Winter Haven	FL
35	29620	Lansing-East Lansing	MI
36	29820	Las Vegas-Paradise	NV
37	32820	Memphis	TN
38	33460	Minneapolis-St. Paul-Bloomington	MN
39	33700	Modesto	CA
40	34940	Naples-Marco Island	FL
41	34980	Nashville-DavidsonMurfreesboroFranklin	TN
42	36100	Ocala	FL
43	36420	Oklahoma City	OK
44	36740	Orlando-Kissimmee-Sanford	FL

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No.	*FIPS*	*Name*	*State*
45	37100	Oxnard-Thousand Oaks-Ventura	CA
46	37460	Panama City-Lynn Haven-Panama City Beach	FL
47	37860	Pensacola-Ferry Pass-Brent	FL
48	38060	Phoenix-Mesa-Glendale	AZ
49	38900	Portland-Vancouver-Hillsboro	OR
50	38940	Port St. Lucie	FL
51	39100	Poughkeepsie-Newburgh-Middletown	NY
52	39580	Raleigh-Cary	NC
53	39900	Reno-Sparks	NV
54	40060	Richmond	VA
55	40140	Riverside-San Bernardino-Ontario	CA
56	40220	Roanoke	VA
57	40900	SacramentoArden-ArcadeRoseville	CA
58	40980	Saginaw-Saginaw Township North	MI
59	41500	Salinas	CA
60	41620	Salt Lake City	UT
61	41700	San Antonio-New Braunfels	TX
62	41740	San Diego-Carlsbad-San Marcos	CA
63	41940	San Jose-Sunnyvale-Santa Clara	CA
64	42020	San Luis Obispo-Paso Robles	CA
65	42220	Santa Rosa-Petaluma	CA
66	43780	South Bend-Mishawaka	IN
67	44700	Stockton	CA
68	45220	Tallahassee	FL
69	45300	Tampa-St. Petersburg-Clearwater	FL
70	45780	Toledo	OH
71	46060	Tucson	AZ
72	46140	Tulsa	OK
73	46700	Vallejo-Fairfield	CA
74	47260	Virginia Beach-Norfolk-Newport News	VA
75	49700	Yuba City	CA