Financial Innovation, Credit Expansion and Unintended Consequences*

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ABSTRACT

Research often documents that significant welfare gains result from the introduction of financial innovations through the improvement in efficiency and lowering of capital costs. However, such claims usually do not consider the effects that innovations may have on related markets. The dramatic expansion in mortgage credit that fueled a remarkable boom and bust in the US housing market offers such an opportunity due to the prominence of the subprime mortgage innovation in the housing credit market. While many studies have examined the spillover effects of subprime credit expansion to other areas of the housing and mortgage markets, the fundamental linkage to other markets remains unclear. 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 long 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, with high-rent payers being most likely to exit the rental market to homeownership. Finally, we present evidence showing that the financial performance of multifamily rental properties reflected the increase in rental lease defaults.

JEL Classification: G0, G13, G18, G2, G21, G28, R28

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PRELIMINARY: PLEASE DO NOT QUOTE

1 Introduction

As Miller (1986) noted over two decades ago, the financial industry is extremely adept at introducing innovative products. For example, Miller (1986) notes that many financial innovations, such as negotiable certificates of deposits, floating-rate bonds, putable bonds, currency swaps, etc., have lowered the cost of capital and helped make industry more efficient and profitable. Furthermore, in an exhaustive review of the extant literature, Frame and White (2004) conclude that the empirical evidence generally supports the position that financial innovations produce positive welfare effects. Similarly, the housing finance industry also experienced a remarkable increase in innovation, with many of these new products tied to growth in asset securitization. However, the empirical research surveyed by Frame and White (2004) focuses on the "first-order" effects of the innovation. For example, Black et al. (1981) show that the introduction of the Ginnie Mae (GNMA) mortgage pass-through security lowered mortgage interest rates while Nanda and Yun (1996) demonstrate that the adoption of poison put options in debt contracts provides significant benefits to issuers. More recently, Gerardi, Rosen and Willen (2010) document how securitization and innovative mortgage products improved mortgage market efficiency by providing credit for households to purchase homes. While some financial innovations are clearly confined to single markets (e.g. poison put options), other innovations could impact participants in related markets (e.g. the introduction of new mortgage products that alters household housing tenure decisions.) We consider the "second order" effects of financial innovation by examining the spillover effect of the growth in an innovation in the primary mortgage market (the subprime mortgage) on the distinct, but related residential rental market.

During the previous decade, the US housing market experienced a remarkable boom and bust spawning a global financial crisis in 2007 and 2008.[1] Due to the profound, lasting

[1] 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 2007-08 financial crisis began as a result of rising defaults among U.S. subprime mortgages.

and wide-ranging effects of this crisis, economists have focused considerable attention on its causes, consequences and possible spillovers to other sectors. For example, the housing boom coincided with a significant growth in mortgage securitization leading many to examine whether lender choices to securitize loans resulted in a reduction in mortgage underwriting standards (Agarwal, Chang and Yavas, 2012; Greenspan, 2010). Others have focused on the question of whether mortgage securitization has prolonged the housing crisis by either impeding or preventing various loss mitigation practices. For example, Agarawal et al (2011) support the earlier findings of Piskorsi, Seru, and Vig (2010) and definitively show that securitization has a negative impact on the likelihood of lender renegotiation and thus increases the probability of foreclosure. Furthermore, Agarawal et al (2012) show that defaulted non-government sponsored enterprise (non-GSE) mortgages (i.e. defaulted subprime mortgages) are significantly more likely to terminate through foreclosure than higher quality mortgages eligible for purchase by the GSEs. 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), 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. 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. 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. Our analysis rests on the fundamental decision households make regarding housing consumption, the decision to rent or own.

In economics, the housing tenure choice literature views owning and renting as substitutes, hence individual tenure choice decisions are technically based on the relative attractiveness of these two alternative options. Household characteristics and financial considerations play 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. 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.

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 temporally, the American dream of homeownership (Bernanke, 2007). For example, the national average homeownership rate grew 2.4% from 67.5% in 2000 to 68.9% in 2006 (Figure 1). This phenomenon was more pronounced in 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 was also changing. For example, Figure 1 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.[2] Consistent with the notion that the characteristics of the renter population shifted during the housing bubble, we see that the

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

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. Furthermore, we also see a corresponding decline in housing affordability (the NAHB/Wells Fargo Housing Opportunity Index) as housing prices increased during the 2002 to 2006 bubble period.

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 payment defaults under these leases during the period of explosive growth in subprime lending. The empirical results document a sustained increase during that period in lease defaults in high subprime MSAs as compared to areas that experienced less subprime activity. After controlling for the effects of other potential determinants of lease defaults, we find a significant (both economically and statistically) positive relation between subprime lending and the likelihood of lease defaults. We also show that the increase in lease defaults resulted from by the migration of low risk renters into homeownership. 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. 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 presents the empirical analysis and section 4 extends the analysis to look at rental losses. Section 5 provides preliminary evidence of the impact of the deterioration in residential renter credit risk on property performance. Finally, section 6 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 2 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 3 shows the relaxation in bank lending standards over this period as reported by the Federal Reserve Board's Bank Officer Survey.[3] 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

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

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 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 4 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.[4] 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 4 the value of $A(\Phi^C)$ is given as the region $Y + Z + M$. The fraction of all 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 4 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 5 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 $R'(\Phi) > R(\Phi)\ \forall\ \Phi$.[5] As Φ^C and Φ^S

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

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

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 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.[6] 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 6 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

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

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 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 Empirical Analysis

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 2001 to December 2006. 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.[7] 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. The rental data were last updated in November 2009, the last month of reporting.[8]

We match the individual lease rental records to the metropolitan (MSA) area to study the effects of subprime activity on rental defaults.[9] We obtain micro-level mortgage data from the Home Mortgage Disclosure Act (HMDA) mortgage origination data for originated purchase loans on owner-occupied houses.[10] We then identify subprime mortgages using the

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

[8]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.

[9]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.

[10]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

Department of Housing and Urban Development (HUD) lists of subprime lenders.[11]

3.1 Univariate Hazard Rates: A Preliminary Analysis

As a preliminary step, we examine basic rental survival and default hazard curves for a random sample of leases distributed across the sample period. We classify MSAs covered by RentBureau into quartile groups according to the percentage of purchase subprime mortgage originations from 2002 to 2006. MSAs in the bottom (top) quartile are classified as low (high) subprime areas. Next, we draw a random sample of 27,500 leases from the MSAs in the top and bottom quartiles. We define a lease default event as the first occurrence of a missed rent payment.

Figure 7 displays the 24-month hazard curves of lease defaults from 2001 to 2006 for the low and high subprime MSA groups generated from the simple Cox proportional hazard models reported in Table 1. As expected, the hazard curves show a steep increase in defaults during the first months, reaching a maximum at around month 5, and a slower downward trend as leases are removed from the sample after the first default event is observed. As noted in Table 1, the insignificant coefficient for *SUBP_DUMMY* 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 7 and Table 1 show statistically higher incidences of lease defaults in the high-subprime MSAs. 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. In addition, the evolution of hazard curves in the high subprime MSAs (Figure 8) shows a pattern of increasing lease defaults coinciding with the growth in subprime lending. For example, lease contracts originated in 2002 have the lowest

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/)

[11]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.

hazard curve while leases originated in 2006, at the peak of the subprime lending market, have the highest hazard curve.[12]

3.2 Multivariate Hazard Analysis

3.2.1 Sample

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 $100 per month. As shown in Table 2, our sample contains 452,701 leases from 1,331 large multifamily properties located in 88 MSAs. 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 340 leases per year. In addition, Table 2 reveals the unbalanced nature of the panel as the number of MSAs covered by RentBureau increases from 24 in 2001 to 81 by 2006 with the average number of leases per MSA ranging from 929 in 2001 to 1,982 in 2006.

Table 3 shows the descriptive statistics for the final lease sample and reveals an interesting characteristic of the mortgage credit expansion. 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 (LC_MRG_ORIG) was 11.8% and ranged from a low of -15.1% in Brownsville, TX to 94.4% in Memphis, TN. 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 16.2% on average across all MSAs and years. At the low end of the distribution, subprime origination activity accounted for 5.0% on average in Wichita Falls, while at the high end

[12] 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. The analysis presented next is based on that observation period, but a 24-month period is used later to test the robustness of the results.

Knoxville experienced an average subprime origination penetration of 37.0%.

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 7.6% 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 $87,250 to $610,000. Meanwhile, the average annual increases in market rent and per-capita gross personal income were 3.7% and 4.3%, 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 5.4% to 88.2%. As noted previously in Figure 1, the national housing opportunity index declined significantly during the housing bubble period.

3.2.2 Cox Proportional Hazard Model

To test the hypothesis that increases in subprime mortgage activity altered the risk distribution in the rental market, we estimate a Cox proportional hazard model of lease default rate. We assume that a renter exits the rental contract either by completing the contract or by defaulting, where the time to default T is a random variable with a continuous probability distribution $f(t)$, where t is a realization of T. The cumulative probability of default is defined as

$$F(t) = \int_0^t f(s)ds \tag{4}$$

and the corresponding survival function is given as

$$S(t) = 1 - F(t) = Pr(T > t). \tag{5}$$

Thus, the probability (l) that the renter will default in the next short time interval Δ, given that the lease is still open is

$$l(t, \Delta t) = Pr(t \leq T \leq t + \Delta t | T \geq t). \tag{6}$$

The hazard rate is the function that characterizes this distribution and is defined as

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{l(t, \Delta t)}{\Delta t} = \frac{f(t)}{S(t)}. \tag{7}$$

Following Cox (1972), we specify the hazard rate of default as

$$\lambda_i(t) = \exp(\beta' X)\lambda_0(t) \tag{8}$$

where λ_0 is the baseline hazard and λ_i is the hazard rate of lease i. Equation (8) is estimated via maximum likelihood.

In order to determine whether the rental household population risk shifted in response to expansion in the subprime lending market, we follow Gross and Souleles (2002) and separate X into components representing the subprime market, lease characteristics, macro economic factors, and location specific factors. Specifically, we assume that X includes both time-variant and time-invariant factors:

$$\beta' X = \beta_0 + \beta_1 SUBP(t) + \beta_2 Y1_i + \beta_3 Y2 + \beta_4 Z(t) \tag{9}$$

where *SUBP(t)* represents the level of subprime activity at time t, $Y1_i$ is a set of the lease's characteristics, $Y2$ represents a set of time-invariant location control factors, and $Z(t)$ is a set a time-varying macroeconomic risk factors.

3.2.3 Control Variables

In (9), we define a proxy for subprime mortgage activity as the lagged percentage of subprime originations relative to the quantity of purchase mortgages originated in the MSA

(*L_SUBP(t)*). We lag the subprime measure by one year because the HMDA data are published annually and do not contain exact transaction dates. Under the hypothesis that subprime mortgage origination activity increased the risk of the rental population, we expect the marginal effect of *L_SUBP(t)* on lease defaults during the 2001-2006 period to be positive.

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 (*LC_MRG_ORIG*). The expected effect of *LC_MRG_ORIG* 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).

To control for changes in macroeconomic conditions over time, we include in (9) the monthly MSA unemployment rate (*UNEMP*) published by Bureau of Labor and Statistics (BLS). Ceteris paribus, an increase in unemployment is expected increase the rate of lease defaults in the area in the long run, consistent with a shift in $r(\Phi)$ in Figure 6 to the right since the renter population becomes riskier. On the other hand, 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 (*LC_INCOME*) from Bureau of Economic Analysis (BEA), will reduce the overall household credit risk (corresponding to the leftward shift in $r(\Phi)$ to $r'(\Phi)$ in Figure (6), resulting in an increase in household movement from renter status to home ownership). We also control for the effect of recent (prior quarter) changes in housing prices within each MSA. To the extent that serial correlation exists in the housing market, an environment of rising house prices increases the incentives to purchase a home in order to benefit from future house price increases.[13] However, higher house prices also make it more difficult for households to qualify for mortgage financing, everything else the same. We expect this second effect to dominate. For example, Ioannides and Kan

[13]Case and Shiller (1989) provide evidence consistent with the assumption that house prices are serially correlated.

(1996) find that house price appreciation discourages renters from becoming homeowners. We measure the change in house prices by the lagged change in the MSA's house price index (*LC_HPI*) 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_C_HPRC_DUMMY*, 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 lagged median house prices (*L_MED_HPRC* in Table 3) from CoreLogic published by the National Association of Home Builders (NAHB). We then construct a low-median house price variable (*LOW_HPRC_DUMMY*) that is equal to 1 for MSAs belonging to the bottom quartile and 0 otherwise. All else the same, we expect more lease defaults in less expensive MSAs. In addition to changes in house price and income, we consider differences in housing affordability across MSAs. NAHB and Wells Fargo produce a Housing Opportunity Index (HOI) comparing median family income to median house prices quarterly at the MSA level.[14] We include the lagged value of that index (*L_HOI*) and a high median income dummy (*HIGH_INC_DUMMY*) that is equal to 1 if the lagged value of the MSA's median family income (*L_MED_INC* in Table 3) is above the national median family income.[15] We expect housing affordability to be positively related to lease defaults.

Although we do not have direct measures of household credit quality or property quality, we include the ratio of individual gross rent to the local fair market rent (*RENT_RATIO*)

[14]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

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

as a proxy for quality.[16] To the extent that household income is positively correlated with credit risk and higher quality buildings that command higher rents cater to higher income households, then we expect *RENT_RATIO* to be negatively related to lease defaults. To measure changes in the local rental market, we include the annual change in the MSA's fair market rent (*C_MKT_RENT*). We do not lag this variable because FMRs are based on the previous year rents.

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 (*L_RENTER_POP*). Since an expansion of the renter population allows property managers to be more selective in renting, *L_RENTER_POP* should be negatively correlated with lease defaults. 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 (*L_SUPPLY_MF*). It is lagged two periods to reflect typical time between permitting and construction completion. For obvious reasons, this variable is expected to be positively correlated with lease defaults.

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

3.2.4 Estimation Results

We report the marginal effects for the estimated coefficients for the Cox proportional hazard model (equations (8) and (9)) in Table 4. The marginal effect of subprime lending (*L_SUBP(t)*) on lease defaults is overwhelmingly positive and both statistically as well as economically significant. The marginal effects indicate that a 1% rise in subprime mort-

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

gage originations translates to a 1% increase in the hazard rate of lease defaults. Therefore, consistent with the predictions from our theoretical model, we see that the expansion of subprime lending during the housing bubble negatively affected the performance of residential leases. We also include the growth in the overall mortgage market (*LC_MRG_ORIG*) and find its estimated marginal effect on lease defaults is small but statistically significant. The marginal effects indicate that a 100 basis point growth in overall purchase mortgage originations results in a 10 basis point increase in the average lease default rate. Thus, these 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).

Turning to the housing market control variables, we find that lease defaults are a decreasing function of recent changes in house prices (*LC_HPI*) and an increasing function of prolonged house price growth (*HIGH_C_HPRC_DUMMY*). The marginal effects for *LC_HPI* indicate that a 1% rise in average house price in the prior quarter (as measured by the change in the MSA's HPI) corresponds roughly to a statistically significant 1.2% decrease in lease defaults. However, the marginal effects indicate that areas that experienced above average house price growth (*HIGH_C_HPRC_DUMMY*) have lease default rates that are 7.5% higher than areas with average to below average house price growth. To further control for heterogeneity in housing affordability across MSAs, we include a measure of house price levels (*LOW_HPRC_DUMMY*) and find that lease defaults are significantly affected by differences in house price levels across MSAs. The marginal effects indicate that renters in areas in the lowest quartile of house prices (*LOW_HPRC_DUMMY*) are 21% more likely to default on their lease payments. Overall, the house price control variables support the hypothesis that areas with a larger rental base due to higher house price growth and lower affordable housing opportunities have lower lease default rates than areas with more affordable housing opportunities.

As expected, we find that income growth (*LC_INCOME*) and lease defaults are positively and statistically related. A 1% income increase is associated to a 0.4% increase in lease defaults. This effect persists even after controlling for housing affordability using *L_HOI* in column 1 and *HIGH_INC_DUMMY* in column 2. These three variables interact with lease defaults in the same manner. The more affordable housing becomes, all else the same, the more likely households are to switch to homeownership, thus leaving behind a riskier renter pool.

We also see that the relative rent cost ratio (*RENT_RATIO*) is inversely associated to lease defaults. Understandably, tenants who can afford rents 1% higher than the MSA's FMR are roughly 0.4% less likely to default. We also see that changes in market rent are statistically significant indicating that a 1% increase in market rents corresponds to a 0.8% increase in lease defaults. Our proxies for rental space supply and demand significantly affect lease defaults as predicted. A 1% increase in the supply of rental units (*L_SUPPLY_MF*) is associated with a 1.9% increase in lease defaults. On the other hand, a similar growth in the renter population (*L_RENTER_POP*), representing the fraction of the state's population in the 20-year to 34-year age group, corresponds to the 3.5% decrease in lease defaults.

Finally, we note that the marginal effect of *UNEMP* is positive and statistically significant indicating that areas with higher unemployment have higher lease default hazard rates. The marginal effect suggests that each 1% point increase in the unemployment rate translates into a 2.9% higher lease default hazard rate.

3.3 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 quintiles by MSA and cohort year according to the contracted gross rent, labeled *Q1_DUMMY* for the bottom quintile to *Q5_DUMMY* for the top quintile. We then interact the rent quintiles with the subprime variable in order to capture the impact of subprime lending on the various renter groups. Column 3 in Table 4 summarizes the results from the estimation of the model 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 quintile, 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, except for the fourth-quintile group. For example, we see that a 1% increase in subprime originations corresponds to a 1.2% increase in lease defaults in the lowest rent group and a 1.5% increase in the top rent quintile.[17] To summarize, all renter groups experienced a significant increase in lease defaults as subprime lending expanded, but as expected, holders of more expensive leases migrated the most from renting to owning, leaving the pool of renters in the higher rent bracket riskier.

3.4 Robustness Checks

3.4.1 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 estimated the Cox proportional hazard model using only leases originated in the 24 MSAs covered by RentBureau during the complete period.[18] We report the marginal effects from this estimation in column (4) of Table 4. First, we note that the marginal effect of subprime lending (*L_SUBP(t)*) on lease defaults remains statistically significant with the same effect as in the full sample model (column (1)).

[17] 1.2% = 0.9% + 0.3% and 1.5% = 0.9%+0.6%

[18] Table A.1 in the Appendix reports the 24 MSAs that had full coverage by RentBureau during the sample period.

The marginal effect indicates that a 1% rise in subprime mortgage originations translates roughly to a 1% increase in the hazard rate of lease defaults. Furthermore, we note that the various control variables retain their statistical and economic significance. Thus, we feel this is compelling evidence that temporal changes in the RentBureau panel are not biasing our primary result.

3.4.2 Sensitivity to Subprime Definitions

Another potential concern is our choice of mortgage origination and subprime metric. Thus, in columns 2, 3, and 4 of Table 5, we examine the sensitivity of the previous results to choice of mortgage origination and subprime metrics (column 1 repeats the baseline model, column 2 in Table 4). In Table 5, *L_SUBP_HP(t)* refers to the percentage of subprime mortgages, with subprime mortgages defined as high-price loans in the HMDA data, relative to the quantity of purchase mortgages. *L_SUBP*(t)*, *L_SUBP_HP*(t)*, and *LC_MRG_ORIG*(t)* are identical to *L_SUBP(t)*, *L_SUBP_HP(t)*, and *LC_MRG_ORIG(t)*, respectively, except that they are based on the dollar volumes rather than the number of mortgage originations. The results based on these alternative metrics confirm the documented significant positive relation between subprime lending and residential lease defaults from 2001 to 2006, 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 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.

3.4.3 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, we re-estimate the model keeping only properties that remained in the sample throughout the study period. Table 6 reproduces our main results in column (1) and estimations based on 2001, 2002, and 2003 properties in the remaining columns. In columns 2 through 4, we see that the marginal effect of subprime originations on lease defaults is even stronger after controlling for property survivorship and the effects of other explanatory variables are unchanged. Therefore, we conclude that rental property conversions were not a determinant factor in higher lease defaults.

3.4.4 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 7 summarizes the estimation results based on the homeownership rate. *L_HOMEOWN* is the one-year lagged MSA homeownership rate or average state homeownership rate for MSAs with missing homeownership data.[19] The variable *2007-09DUMMY* is a lease-year dummy variable set to 0 for leases originated before 2007 and 1 for leases originated in and after 2007. *2008-09DUMMY* and *2009DUMMY* are constructed the same way using as

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

breaking points 2008 and 2009, respectively. These dummy variables are then interacted with homeownership (e.g., *L_HOMEOWN·2007-09DUMMY*) to capture changes in the marginal effect of *L_HOMEOWN* on lease defaults as the housing downturn gained momentum. The marginal effect of homeownership of lease defaults from 2001 to 2006 (Columns (1) in Table 7) 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 column (2) shows a similar effect of homeownership on lease defaults. However, it is slightly higher after 2006 as reflected in the coefficients of the homeownership interaction variables in columns (3) and (4). This continued positive effect of homeownership on lease defaults may be due to a lengthy foreclosure process and to the fact that the homeownership variable is lagged by one year. This argument is confirmed by the negative marginal effect of the homeownershiop interaction variable in 2009 in column (5). Overall, the substitution of homeownership for subprime originations strengthen the argument defended in the paper.

4 Potential Rental Income Losses

The previous section shows that the hazard of lease defaults, 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 Figure 7, Figure 8, and Table 1. In this section we estimate and compare potential rental income losses in high-subprime and low-subprime metropolitan areas. As previously noted, MSAs are put 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 (loss estimates derived from these measures may however be overestimated). 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 8 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, 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.

5 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 *L_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*).[20] The resulting data sample is an unbalanced panel of 625 observations, representing 51 MSAs and 24 quarterly periods from 2001 to 2006. Columns 1 and 2 in Table 9 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 9 yield inconclusive results. Since

[20]NPI city returns are matched to MSAs.

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 9 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.[21] 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 (*L_DEF_INDEX_1* and *L_DEF_INDEX_2*), 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).[22] Our dataset contains 623 quarterly 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.[23].

Table 10 presents the results of the MSA panel regression estimations. As expected, the estimated coefficients for *L_DEF_INDEX_1* and *L_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

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

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

[23] 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)

also positive and highly significant. Clearly, investors appears 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.

6 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 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.

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.

References:

Agarwal, Sumit, Brent W. Ambrose, Souphala Chomsisengphet and Anthony B. Sanders (2011). *Thy Neighbor's Mortgage: Does Living in a Subprime Neighborhood Effect On Probability of Default?* Real Estate Economics, 39(4), 1-22 .

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff, "The role of securitization in mortgage renegotiation." *Journal of Financial Economics* (2011), 102(3), 559-578.

Agarwal, Sumit, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff, "Predatory Lending and the Subprime Crisis." (2012) Federal Reserve Bank of Chicago working paper.

Agarwal, Sumit, Yan Chang, and Abdullah Yavas, "Adverse Selection in Mortgage Securitization." *Journal of Financial Economics* (2012), forthcoming.

Ambrose, Brent, Anthony Pennington-Cross and and Anthony Yezer (2002). "Credit Rationing in the U.S. Mortgage Market: Evidence from Variation in FHA Market Shares." *Journal of Urban Economics,* 51, 271-294.

Anderson, Charles, Dennis Capozza and Robert Van Order (2008). "Deconstructing the Subprime Debacle Using New Indices of Underwriting Quality and Economic Conditions: A First Look." University of Michigan Working Paper.

Ben-David, Itzhak. "Financial constraints and inflated home prices during the real estate boom." *American Economic Journal: Applied Economics* 3(3), 55-78.

Bernanke, Ben (2007). "Bank Structure and Competition." Speech at the 43rd conference of the Chicago Federal Reserve Bank
(http://www.federalreserve.gov/newsevents/speech/bernanke20070517a.htm).

Black, Deborah G., Kenneth D. Garbade, and William L. Silber (1981). "The Impact of the GNMA Pass-Through Program on FHA Mortgage Costs," *Journal of Finance*, 36:2, 457-469.

Calem, Paul, Kevin Gillen and Susan Wachter (2004). "The Neighborhood Distribution of Subprime Mortgage Lending." *Journal of Real Estate Finance and Economics,* 29(4), 393-410.

Calem, Paul, Simon Firestone and Susan M. Wachter (2010). "Credit Impairment and Housing Tenure Status." *Journal of Housing Economics,* 19, 219-232.

Case, Karl E. and Robert J. Shiller (1989). "The Efficiency of the Market for Single-Family Homes." *American Economic Review* 79(1), 125-137.

Chomsisengphet, Souphala and Anthony Pennington-Cross (2006). "The Evolution of the Subprime Mortgage Market." *Federal Reserve Bank of St. Louis Review,* 88(10), 31-56.

Coleman IV, Majore, Michael LaCour-Little and Kerry Vandell (2008). "Subprime Lending and the Housing Bubble: Tail Wags Dog?" *Journal of Housing Economics,* 17, 272-290.

Collison, Rob (2011). "Rental Housing Affordability Dynamics, 1990-2009." *Cityscape: A Journal of Policy Development and Research,* 13(3), 71-103.

Cox, D. R. (1972). "Regression Models and Life-Tables." *Journal of the Royal Statistical Society,* B34(2), 187-220.

Danis, Michell A. and Anthony Pennington-Cross, 2008. "The delinquency of Subprime Mortgages." *Journal of Economics and Business,* 60, 67-90.

Demyanyk, Yuliya and Otto V. Hemert (2009). "Understanding the Subprime Mortgage Crisis." *Review of Financial Studies.* 24(6), 1848-1880.

Duca, John V. and Stuart S. Rosenthal (1994). "Borrowing Constraints and access to Owner-occupied Housing." *Regional Science and Urban Economics,* 24, 301-322.

Ferguson, Micheal and Stephen Peters (1995). "What Constitutes Evidence of Discrimination in Lending?" *Journal of Finance,* 50(2), 739-748.

Frame, W. Scott, and Lawrence J. White (2004). "Empirical Studies of Financial Innovation: Lots of Talk, Little Action?" *Journal of Economic Literature* 42, 116-144.

Gerardi, Kristopher S., Harvey S. Rosen, and Paul S. Willen (2010). "The Impact of Deregulation and Financial Innovation on Consumers: The Case of the Mortgage Market," *Journal of Finance,* 65:1, 333-360.

Glaeser, Edward, Joshua Gottlieb and Joseph Gyourko (2010). "Can Cheap Credit Explain the Housing Boom?" NBER Working Paper Series, 16230.

Gorton, Gary B., (2010). *Slapped by the Invsible Hand, The Panic of 2007.* New York, NY: Oxford University Press.

Greenspan, Alan, (2010). "The Crisis," paper presented at the April 2010 conference of the Brookings Papers on Economic Activity.

Greenspan, Alan and James Kennedy (2008). "Sources and Uses of Equity Extracted from Homes." *Oxford Review of Economic Policy,* 24(1), 120-144.

Gross, David and Nicholas Souleles (2002). "An Empirical Analysis of Personal Bankruptcy and Delinquency." *The Society for Financial Studies,* 15(1), 319-347

Haurin, Donald, Patric Hendershott and Susan Wachter (1997). "Borrowing Constraints and the Tenure Choice of Young Households." *Journal of Housing Research,* 8(2), 137-154.

Henderson, J. V. and Y. M. Ioannides (1983). "A Model of Housing Tenure Choice." *The American Economic Review,* 73(1), 98-113.

Ioannides, Yannis M. and Stuart S. Rosenthal (1994). "Estimating the Consumption and Investment Demands for Housing and their Effect on Housing Tenure Status." *The Review of Economics and Statistics,* 76(1), 127-141.

Ioannides, Yannis M. and Kamhon Kan (1996). "Structural Estimation of Residential Mobility and Housing Tenure Choice." *Journal of Regional Science,* 36(3), 335-363.

Keys, B.J., T. Mukherjee, A. Seru, and V. Vig, (2010). "Did securitization lead to lax screening? Evidence from subprime loans." *Quarterly Journal of Economics* 125 (1), 307-362.

Kiff, John and Paul Mills (2007). "Money for Nothing and Checks for Free: Recent Developments in U.S. Subprime Mortgage Markets." IMF Working Paper, WP/07/188.

Kroszner, Randall S., (November 5, 2007). "The Challenges Facing Subprime Mortgage Borrowers." Remarks at the Consumer Bankers Association 2007 Fair Lending Conference, Washington, D.C., (www.federalreserve.gov/newsevents/speech/kroszner20071105a.htm)

Linneman, Peter, Isaac Megboluge, Susan Watcher and Man Cho (1997). "Do Borrowing Constraints Change U.S. Homeownership Rates?" *Journal of Housing Economics,* 6, 318-333.

Linneman, Peter and Susan Wachter (1989). "The Impacts of Borrowing Constraints on Homeownership." *AREUEA Journal,* 17(4), 389-402.

Longstaff, Francis A. (2010). "The Subprime Credit Crisis and Contagion in Financial Markets." *Journal of Financial Economics,* 97, 436-450.

Miller, Merton H. (1986). "Financial Innovation: The Last Twenty Years and the Next." *Journal of Financial and Quantitative Analysis,* 21:4, 459-471.

Mayer, Chris and Karen Pence (2008). "Subprime Mortgages: What, Where, and to Whom?" National Bureau of Economic Research, Working Paper 14083.

Mian, Atif and Amir Sufi (2009). "The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis." *Quarterly Journal of Economics,* 124(4), 1449-1496.

Nanda, Vikram and Youngleol Yun (1996). "Financial Innovation and Investor Wealth: A Study of the Poison Put in Convertible Bonds," *Journal of Corporate Finance,* 3:1, 1-22.

Piskorski, Tomasz, Amit Seru and Vikrant Vig (2010). "Securitization and Distressed Loan Negotiation: Evidence from the Subprime Mortgage Crisis." *Journal of Financial Economics,* 97(3), 369-397.

Watcher, Susan, Andrey Pavlov and Zoltan Pozsar (2008). "Subprime Lending and Real Estate Markets." University of Pennsylvania ILE Research Paper, 08-35.

Table 1: Simple Hazard Analysis

	2002	*2003*	*2004*	*2005*	*2006*
SUBP_DUMMY	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: *SUBP_DUMMY* 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 *SUBP_DUMMY* 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

		2001	*2002*	*2003*	*2004*	*2005*	*2006*	*Total*
Leases		22,291	32,199	49,504	75,132	113,045	160,530	*452,701*
Properties		195	308	438	659	924	1,188	*1,331*
	Avg. leases	114	105	113	114	122	135	*340*
	Min. leases	5	5	4	5	5	5	
	Max. leases	711	646	793	722	1,320	1,468	
MSAs		24	41	45	51	57	81	*88*
	Avg. leases	929	785	1,100	1,473	1,983	1,982	*5,144*
	Min. leases	33	33	43	32	32	36	
	Max. leases	5,737	8,556	13,125	20,642	26,556	26,769	

Note: Leases are classified by cohort year, the year of the first rental payment reported by RentBureau, which is not necessarily the year of the first payment under the lease. For each cohort year, only MSAs with at least 40 leases are retained, resulting in the final sample containing 88 MSAs, listed in the Appendix (Source: RentBureau)

Table 3: Descriptive Statistics

Variable	Description	Mean	SDV	Min	Max
Mortgage Credit Conditions					
L_SUBP	Proportion of subprime mortgages in the quantity of purchase mortgages originated in the MSA during the year (lagged 1 year)	16.2%	6.0%	5.0%	37.0%
LC_MRG_ORIG	Percentage change in the number of purchase mortgages originated in the MSA during the year (lagged 1 year)	11.8%	18.7%	-15.1%	94.4%
Housing Market Conditions					
LC_HPI	Percentage change in the MSA' quarterly HPI (lagged 1 quarter)	1.9%	1.2%	-1.0%	6.0%
L_MED_HPRC	Lagged quarterly median house prices for MSA	$189,361	$112,389	$87,250	$610,000
L_HOI	Lagged quarterly NAHB/Well Fargo housing opportunity index (HOI) values for the MSA	59.6%	22.3%	5.4%	88.2%
C_MKT_RENT	Percentage change in fair market rent (FMR) in the MSA	3.7%	3.9%	-10.2%	21.4%
RENT_RATIO	Contrated lease rent over MSA FMR at lease origination	113.6%	19.2%	74.9%	169.0%
L_SUPPLY_MF	Number of units in multifamily building permits issued in the MSA in the quarter (lagged 2 quarters and logged)	1,838	2,601	0	14,523
Local Demographic and Economic Conditions					
UNEMP	Monthly unemployment rate in the MSA	5.0%	1.3%	3.2%	9.9%
LC_INCOME	Percentage change in per-capita annual income in the MSA (lagged 1 year)	4.3%	1.7%	-1.4%	12.1%
L_MED_INC	Lagged annual median family income estimates in the MSA	$56,492	$10,438	$31,850	$95,188
L_RENTER_POP	Proportion the 20- to 34-year age group in the state's population (lagged 1 year)	21.0%	1.3%	18.8%	25.5%

Note: These statistics are based on MSA or state averages from January 2001 to December 2006.

Table 4: Cox Proportional Hazard Model of Lease Defaults

	(1)	*(2)*	*(3)*	*(4)* *2001 MSAs*
Mortgage Credit Conditions				
L_SUBP	1.010***	1.011***	1.009***	1.010***
	(11.54)	(13.14)	(9.15)	(7.37)
L_SUBP · Q2_DUMMY			1.003***	
			(6.48)	
L_SUBP · Q3_DUMMY			1.004***	
			(7.63)	
L_SUBP · Q4_DUMMY			1.002***	
			(2.67)	
L_SUBP · Q5_DUMMY			1.006***	
			(7.03)	
LC_MRG_ORIG	1.001***	1.001***	1.001***	1.001***
	(10.75)	(9.86)	(9.92)	(7.72)
Housing Market Conditions				
LC_HPI	0.988***	0.984***	0.984***	0.969***
	(-7.05)	(-9.33)	(-9.32)	(-14.95)
HIGH_C_HPRC_DUMMY	1.075***	1.079***	1.079***	0 .999
	(5.96)	(6.22)	(6.23)	(-0.09)
LOW_HPRC_DUMMY	1.205***	1.172***	1.180***	1.326***
	(14.71)	(11.97)	(12.41)	(15.80)
C_MKT_RENT	1.008***	1.008***	1.007***	1.007***
	(14.46)	(13.58)	(12.82)	(9.17)
RENT_RATIO	0.996***	0.996***	0.995***	0.995***
	(-51.33)	(-50.19)	(-32.64)	(-53.72)
L_SUPPLY_MF	1.019***	1.052***	1.051***	1.096***
	(6.05)	(14.12)	(13.71)	(15.85)
Local Demographic and Economic Conditions				
UNEMP	1.029***	1.034***	1.035***	0 .968***
	(6.43)	(7.25)	(7.42)	(-4.69)
LC_INCOME	1.004**	1.006***	1.006***	1.003
	(2.48)	(3.62)	(3.72)	(1.39)
L_HOI	1.005***	1.005***	1.005***	1.006***
	(11.92)	(12.63)	(12.78)	(12.19)
HIGH_INC_DUMMY		0.914***	0.916***	0.977**
		(-9.92)	(-9.73)	(-2.18)
L_RENTER_POP	0.965**	0.954***	0.956**	0.957**
	(-2.51)	(-3.34)	(-3.21)	(-2.88)
Year Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
State Fixed Effects	*Yes*	*Yese*	*Yes*	*Yes*
Num. Observations	*452,701*	*450,163*	*450,163*	*347,811*
Wald Chi2	*4,858*	*4,887*	*4,892*	*4,726*

Table 4 continued

Note: This table reports the marginal effects for the estimation of the Cox proportional hazard model of lease defaults based on a 12-month observation period from lease origination and uses all leases in the sample for the 6-year period from January 2001 to December 2006. Column (4) reports the Cox proportional hazard model for the 24 MSAs tracked over all years (Table A.1). *L_SUBP(t)* is the lagged percentage of subprime purchase originations relative to the quantity of purchase mortgages originated in the MSA. *LC_MRG_ORIG(t)* represents the lagged percentage change in the quantity of purchase mortgages from HMDA originated in the MSA. *LC_HPI* is the percentage change in the MSA' quarterly Federal Housing Finance Agency House Price Index (HPI) (lagged 1 quarter) and *HIGH_C_HPRC_DUMMY* is a dummy variable equal to 1 if the MSA's average house price growth (using HPI) over the previous three years is above the sample average and equal to 0 otherwise. Using lagged median house prices from the National Association of Home Builders (NAHB), *LOW_HPRC_DUMMY* is an indicator variable equal to 1 for MSAs belonging to the bottom quartile and 0 otherwise. *L_HOI* is the lagged quarterly MSA level NAHB/Well Fargo housing opportunity index (HOI). *C_MKT_RENT* is the percentage change in the MSA fair market rent (FMR) and *RENT_RATIO* is the ratio of the contracted lease rent to the MSA FMR at lease origination. *L_SUPPLY_MF* is the number of units in multifamily building permits issued in the MSA in the quarter (lagged 2 quarters and logged). *UNEMP* is the monthly unemployment rate in the MSA. *LC_INCOME* is the percentage change in the MSA per-capita annual income (lagged 1 year) and *HIGH_INC_DUMMY*) is a dummy variable equal to 1 if the lagged value of the MSA's median family income is above the national median family income. *L_RENTER_POP* is the proportion of the 20- to 34-year age group in the state's population (lagged 1 year). We classify leases into quintiles by MSA and cohort year according to the contracted gross rent, labeled *Q1_DUMMY* for the bottom quintile to *Q5_DUMMY* for the top quintile. We then interact the rent quintiles with the subprime variable in order to capture the impact of subprime lending on the various renter groups. The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 5: Cox Proportional Hazard Model Estimations Based on Various Subprime Metrics

	(1)	*(2)*	*(3)*	*(4)*
Mortgage Credit Conditions				
L_SUBP	1.011***			
	(13.14)			
L_SUBP_HP		1.003***		
		(4.66)		
*L_SUBP**			1.014***	
			(12.93)	
*L_SUBP_HP**				1.004***
				(5.00)
LC_MRG_ORIG	1.001***	1.001***		
	(9.86)	*(9.61)*		
*LC_MRG_ORIG**			1.001***	1.001***
			(9.60)	*(9.26)*
Housing Market Conditions				
LC_HPI	0.984***	0.987***	0.983***	0.987***
	(-9.33)	*(-7.36)*	*(-9.59)*	*(-7.30)*
HIGH_C_HPRC_DUMMY	1.079***	1.059***	1.082***	1.057***
	(6.22)	*(4.76)*	*(6.37)*	*(4.60)*
LOW_HPRC_DUMMY	1.172***	1.173***	1.169***	1.169***
	(11.97)	*(12.03)*	*(11.79)*	*(11.76)*
C_MKT_RENT	1.008***	1.007***	1.007***	1.007***
	(13.58)	*(11.46)*	*(13.04)*	*(11.31)*
RENT_RATIO	0.996***	0.996***	0.996***	0.996***
	(-50.19)	*(-49.92)*	*(-50.10)*	*(-49.95)*
L_SUPPLY_MF	1.052***	1.053***	1.051***	1.053***
	(14.12)	*(14.29)*	*(13.59)*	*(14.16)*
Local Demographic and Economic Conditions				
UNEMP	1.034***	1.044***	1.027***	1.042***
	(7.25)	*(9.38)*	*(5.52)*	*(8.73)*
LC_INCOME	1.006***	1.006***	1.007***	1.007***
	(3.62)	*(3.66)*	*(3.87)*	*(4.00)*
L_HOI	1.005***	1.004***	1.006***	1.005***
	(12.63)	*(9.54)*	*(13.52)*	*(10.51)*
HIGH_INC_DUMMY	0.914***	0.915***	0.919***	0.917***
	(-9.92)	*(-9.79)*	*(-9.24)*	*(-9.60)*
L_RENTER_POP	0.954***	0.961***	0.935***	0.954***
	(-3.34)	*(-2.82)*	*(-4.75)*	*(-3.36)*
Year Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
State Fixed Effects	*Yes*	*Yese*	*Yes*	*Yes*
Num. Observations	*450,163*	*450,163*	*450,163*	*450,163*
Wald Chi2	*4,887*	*4,704*	*4,856*	*4,671*

Table 5 continued

Note: This table reports the marginal effects from the estimation of the Cox proportional hazard model of lease defaults based on a 12-month observation period from lease origination and uses all leases in the sample for the 6-year period from January 2001 to December 2006. *L_SUBP(t)* is the lagged percentage of quantity of purchase mortgages from HMDA originated in the MSA by HUD subprime lenders, whereas *L_SUB_HP(t)* is the lagged percentage of quantity of purchase mortgage originations in the MSA classified as high-price mortgage in the HMDA data. *LC_MRG_ORIG(t)* represents the lagged percentage change in the quantity of purchase mortgage originations from HMDA in the MSA. *L_SUBP*(t)*, *SUBP_HP*(t)*, and *LC_MRG_ORIG*(t)* are the corresponding variables based on the volumes, rather than the quantities, of purchase mortgage originations. *LC_HPI* is the percentage change in the MSA' quarterly Federal Housing Finance Agency House Price Index (HPI) (lagged 1 quarter) and *HIGH_C_HPRC_DUMMY* is a dummy variable equal to 1 if the MSA's average house price growth (using HPI) over the previous three years is above the sample average and equal to 0 otherwise. Using lagged median house prices from the National Association of Home Builders (NAHB), *LOW_HPRC_DUMMY* is an indicator variable equal to 1 for MSAs belonging to the bottom quartile and 0 otherwise. *L_HOI* is the lagged quarterly MSA level NAHB/Well Fargo housing opportunity index (HOI). *C_MKT_RENT* is the percentage change in the MSA fair market rent (FMR) and *RENT_RATIO* is the ratio of the contracted lease rent to the MSA FMR at lease origination. *L_SUPPLY_MF* is the number of units in multifamily building permits issued in the MSA in the quarter (lagged 2 quarters and logged). *UNEMP* is the monthly unemployment rate in the MSA. *LC_INCOME* is the percentage change in the MSA per-capita annual income (lagged 1 year) and *HIGH_INC_DUMMY*) is a dummy variable equal to 1 if the lagged value of the MSA's median family income is above the national median family income. *L_RENTER_POP* is the proportion of the 20- to 34-year age group in the state's population (lagged 1 year). The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 6: Same-Properties Cox Proportional Hazard Model Estimations

	(1) *All Sample*	*(2)* *2001 Properties*	*(3)* *2002 Properties*	*(4)* *2003 Properties*
Mortgage Credit Conditions				
L_SUBP	1.011***	1.023***	1.020***	1.015***
	(13.14)	*(14.11)*	*(15.85)*	*(13.87)*
LC_MRG_ORIG	1.001***	1.000	1.000**	1.000***
	(9.86)	*(-0.27)*	*(2.25)*	*(3.70)*
Housing Market Conditions				
LC_HPI	0.984***	1.009***	1.015***	1.017***
	(-9.33)	*(3.07)*	*(6.16)*	*(8.24)*
HIGH_C_HPRC_DUMMY	1.079***	1.012	1.039***	1.111***
	(6.22)	*(0.75)*	*(2.93)*	*(8.31)*
LOW_HPRC_DUMMY	1.172***	1.176***	1.210***	1.193***
	(11.97)	*(6.81)*	*(11.56)*	*(11.46)*
C_MKT_RENT	1.008***	1.009***	1.013***	1.012***
	(13.58)	*(8.78)*	*(14.85)*	*(15.88)*
RENT_RATIO	0.996***	0.996***	0 .997***	0.995***
	(-50.19)	*(-24.02)*	*(-26.19)*	*(-47.64)*
L_SUPPLY_MF	1.052***	1.006	1.086***	1.032***
	(14.12)	*(0.71)*	*(15.68)*	*(7.09)*
Local Demographic and Economic Conditions				
UNEMP	1.034***	1.006	1.039***	1.071***
	(7.25)	*(0.66)*	*(5.76)*	*(12.15)*
LC_INCOME	1.006***	0.992***	1.000	1.014***
	(3.62)	*(-3.06)*	*(0.15)*	*(7.62)*
L_HOI	1.005***	1.003***	1.001*	1.003***
	(12.63)	*(4.18)*	*(1.68)*	*(5.23)*
HIGH_INC_DUMMY	0.914***	1.046***	0.962***	0.957***
	(-9.92)	*(3.01)*	*(-3.08)*	*(-3.94)*
L_RENTER_POP	0.954***	1.137***	1.109***	1.081***
	(-3.34)	*(6.24)*	*(5.89)*	*(4.81)*
Year Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
State Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*
Num. Observations	*450,163*	*145,737*	*215,900*	*291,512*
Wald Chi2	*4,887*	*2,609*	*3,616*	*4,951*

Table 6 continued

Note: This table reports the marginal effects from the estimation of the Cox proportional hazard model of lease defaults based on a 12-month observation period from lease origination and uses all leases in the sample for the 6-year period from January 2001 to December 2006. Column (1) repeats the base estimation in Column (1) of Table 5. Columns (2) through (4) control for properties - for example, the estimation results in column (2) are based on 2001 properties only. *L_SUBP(t)* is the lagged percentage of quantity of purchase mortgages from HMDA originated in the MSA by HUD subprime lenders, whereas *L_SUB_HP(t)* is the lagged percentage of quantity of purchase mortgage originations in the MSA classified as high-price mortgage in the HMDA data. *LC_MRG_ORIG(t)* represents the lagged percentage change in the quantity of purchase mortgage originations from HMDA in the MSA. *LC_HPI* is the percentage change in the MSA' quarterly Federal Housing Finance Agency House Price Index (HPI) (lagged 1 quarter) and *HIGH_C_HPRC_DUMMY* is a dummy variable equal to 1 if the MSA's average house price growth (using HPI) over the previous three years is above the sample average and equal to 0 otherwise. Using lagged median house prices from the National Association of Home Builders (NAHB), *LOW_HPRC_DUMMY* is an indicator variable equal to 1 for MSAs belonging to the bottom quartile and 0 otherwise. *L_HOI* is the lagged quarterly MSA level NAHB/Well Fargo housing opportunity index (HOI). *C_MKT_RENT* is the percentage change in the MSA fair market rent (FMR) and *RENT_RATIO* is the ratio of the contracted lease rent to the MSA FMR at lease origination. *L_SUPPLY_MF* is the number of units in multifamily building permits issued in the MSA in the quarter (lagged 2 quarters and logged). *UNEMP* is the monthly unemployment rate in the MSA. *LC_INCOME* is the percentage change in the MSA per-capita annual income (lagged 1 year) and *HIGH_INC_DUMMY*) is a dummy variable equal to 1 if the lagged value of the MSA's median family income is above the national median family income. *L_RENTER_POP* is the proportion of the 20- to 34-year age group in the state's population (lagged 1 year). The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 7: Cox Proportional Hazard Model Estimations using Homeownership

	(1) 2001-2006	(2) 2001-2009	(3) 2001-2009	(4) 2001-2009	(5) 2001-2009
Homeownership					
L_HOMEOWN	1.013***	1.014***	1.012***	1.011***	1.015***
	(11.56)	*(21.05)*	*(18.10)*	*(15.97)*	*(22.23)*
L_HOMEOWN · 2007-09DUMMY			1.002***		
			(20.62)		
L_HOMEOWN · 2008-09DUMMY				1.004***	
				(51.90)	
L_HOMEOWN · 2009DUMMY					0.999***
					(-13.01)
Housing Market Conditions					
LC_HPI	0.974***	0.981***	0.986***	0.986***	0.982***
	(-17.39)	*(-31.59)*	*(-20.53)*	*(-22.71)*	*(-29.94)*
HIGH_C_HPRC_DUMMY	1.028**	1.041***	1.041***	1.010**	1.044***
	(2.41)	*(9.33)*	*(9.30)*	*(2.33)*	*(9.99)*
LOW_HPRC_DUMMY	1.126***	1.078***	1.095***	1.138***	1.072***
	(8.69)	*(8.97)*	*(10.77)*	*(15.38)*	*(8.25)*
C_MKT_RENT	1.007***	0.998***	0.997***	0.998***	0.997***
	(11.85)	*(-5.34)*	*(-8.11)*	*(-5.43)*	*(-7.14)*
RENT_RATIO	0.996***	0.996***	0.996***	0.996***	0.996***
	(-49.18)	*(-74.23)*	*(-73.57)*	*(-74.42)*	*(-74.61)*
L_SUPPLY_MF	1.047***	1.019***	1.021***	1.018***	1.020***
	(12.80)	*(11.24)*	*(12.27)*	*(10.75)*	*(11.65)*
Local Demographic and Economic Conditions					
UNEMP	1.033***	1.029***	1.026***	1.000	1.039***
	(7.31)	*(22.86)*	*(20.13)*	*(-0.25)*	*(26.30)*
LC_INCOME	1.002	1.010***	1.013***	1.016***	1.010***
	(1.30)	*(11.01)*	*(13.12)*	*(16.38)*	*(10.75)*
L_HOI	1.000	1.001***	1.001***	0.999***	1.001***
	(-1.22)	*(5.42)*	*(7.41)*	*(-3.07)*	*(6.08)*
HIGH_INC_DUMMY	0.937***	0.972***	0.976***	0.992*	0.972***
	(-7.20)	*(-5.75)*	*(-4.98)*	*(-1.68)*	*(-5.77)*
L_RENTER_POP	0.794***	0.794***	0.859***	0.889***	0.787***
	(-17.61)	*(-38.79)*	*(-21.42)*	*(-18.81)*	*(-39.94)*
State Fixed Effects	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Num. Observations	*450,159*	*1,169,455*	*1,169,455*	*1,169,455*	*1,169,455*
Wald Chi2	*4,052*	*15,802*	*16,100*	*18,351*	*15,857*

Table 7 continued

Note: This table reports the marginal effects from the estimation of the Cox proportional hazard model of lease defaults based on a 12-month observation period from lease origination. Column (1) reports the estimation results based on 2001-2006 leases. The remaining columns extend the study through 2009. *L_HOMEOWN* is the one-year lagged MSA homeownership rate or average state homeownership rate for MSAs with missing homeownership data. The variable *2007-09DUMMY* is a lease-year dummy variable set to 0 for leases originated before 2006 and 1 for leases originated after 2006. The variables *2008-09DUMMY* and *2009DUMMY* are constructed the same way using as breaking points 2007 and 2008, respectively. These dummies are then interacted with the homeownership variable (e.g., *L_HOMEOWN* · *2007-09DUMMY*). *LC_HPI* is the percentage change in the MSA' quarterly Federal Housing Finance Agency House Price Index (HPI) (lagged 1 quarter) and *HIGH_C_HPRC_DUMMY* is a dummy variable equal to 1 if the MSA's average house price growth (using HPI) over the previous three years is above the sample average and equal to 0 otherwise. Using lagged median house prices from the National Association of Home Builders (NAHB), *LOW_HPRC_DUMMY* is an indicator variable equal to 1 for MSAs belonging to the top quartile and 0 otherwise. *L_HOI* is the lagged quarterly MSA level NAHB/Well Fargo housing opportunity index (HOI). *C_MKT_RENT* is the percentage change in the MSA fair market rent (FMR) and *RENT_RATIO* is the ratio of the contracted lease rent to the MSA FMR at lease origination. *L_SUPPLY_MF* is the number of units in multifamily building permits issued in the MSA in the quarter (lagged 2 quarters and logged). *UNEMP* is the monthly unemployment rate in the MSA. *LC_INCOME* is the percentage change in the MSA per-capita annual income (lagged 1 year) and *HIGH_INC_DUMMY*) is a dummy variable equal to 1 if the lagged value of the MSA's median family income is above the national median family income. *L_RENTER_POP* is the proportion of the 20- to 34-year age group in the state's population (lagged 1 year). The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 8: 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 9: 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. 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 5. The robust t-statistics are noted in parentheses with 1, 2, and 3 stars indicating statistical significance at 10%, 5%, and 1%, respectively.

Table 10: 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 . 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 5. *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.

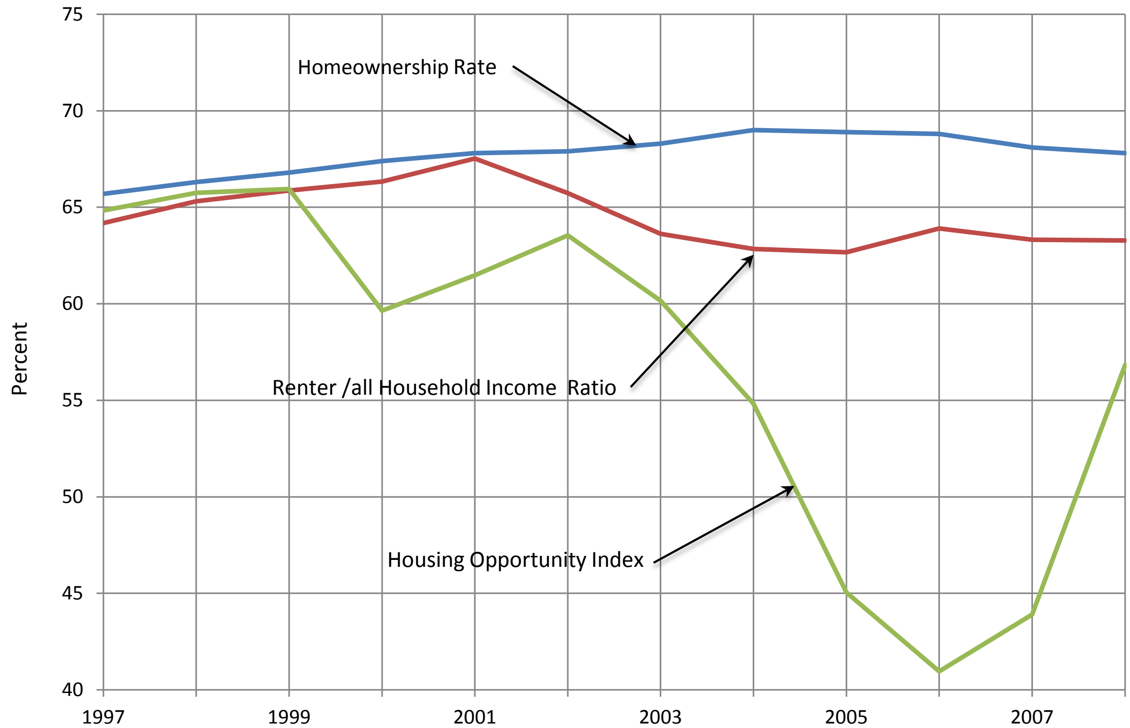

Figure 1: **Homeownership Rates, Median Renter Income/All Household Income Ratio, and Housing Opportunity Index**
(Source: U.S. Census Bureau and the National Association of Home Builders (NAHB))

Figure 2: **Seasonally Adjusted Monthly Unemployment Rates**
(Source: Bureau of Labor Statistics)

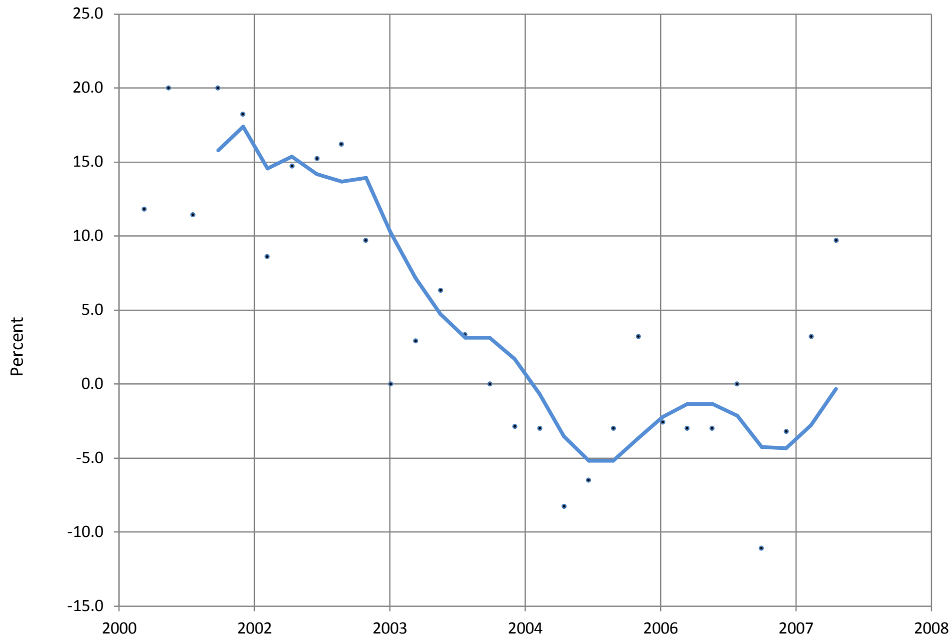

Figure 3: **4-quarter Moving Average of Net Percentage of Domestic Respondents Tightening Standards on Consumer Loans, Credit Cards (DRTSCLCC)**
(Source: Board of Governors of the Federal Reserve System)

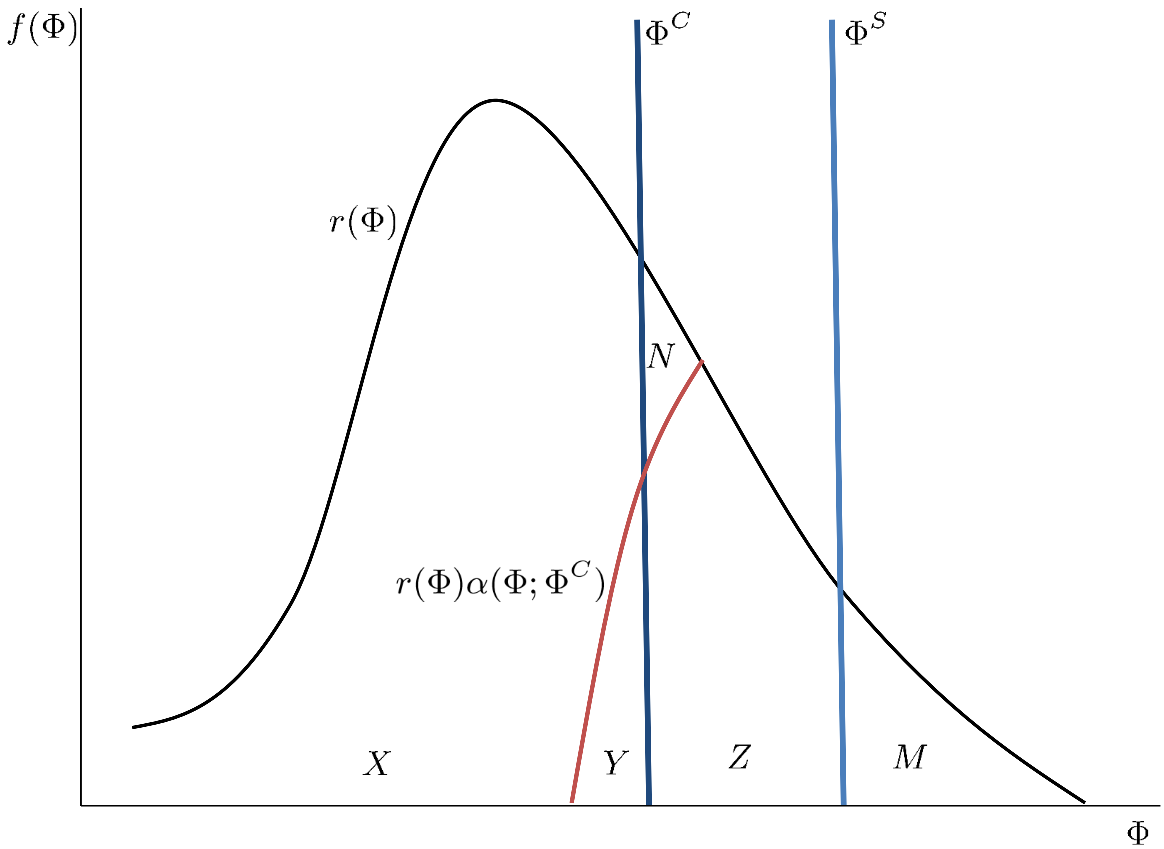

Figure 4: **The Distribution of Conventional, Subprime, and Rental Households**
Note: $r(\Phi)$ = marginal probability density function of the household credit risk; $\alpha(\Phi;\Phi^C)$ =share of households with credit risk Φ that apply for subprime mortgages given conventional underwriting standards (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.

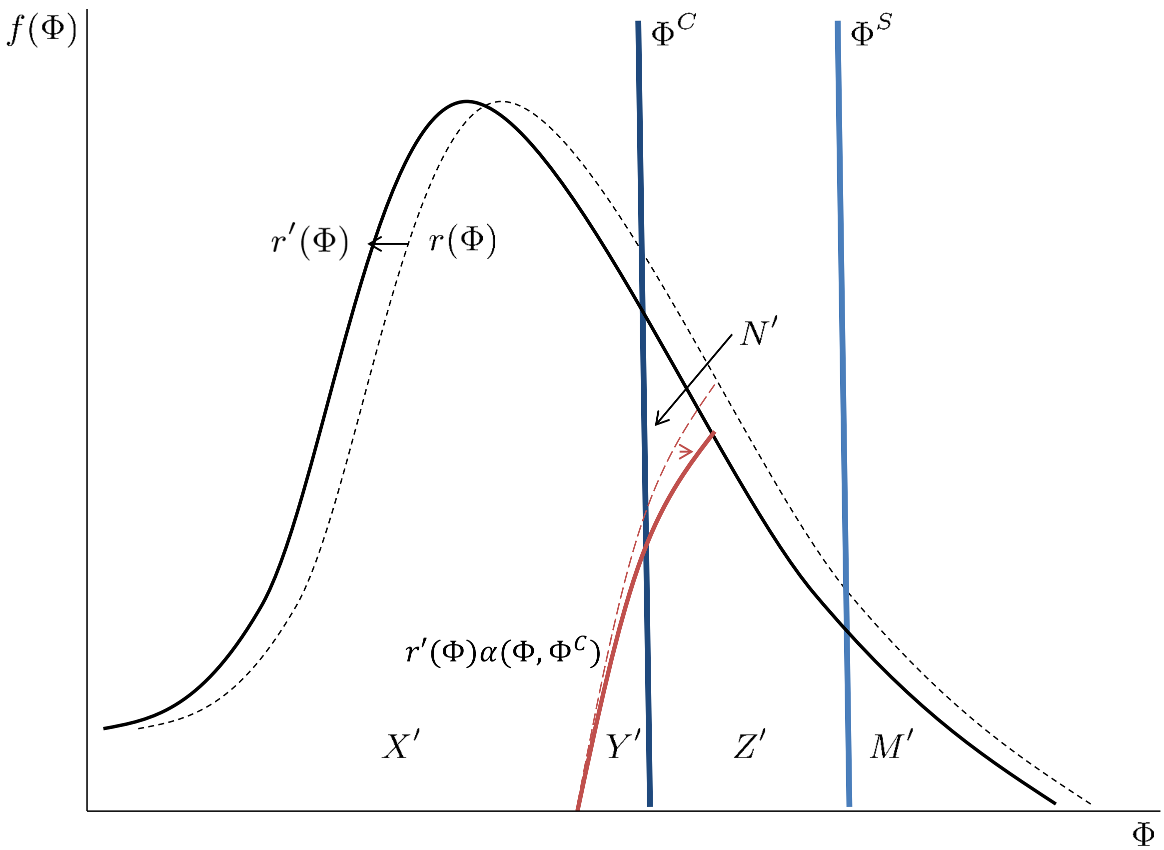

Figure 5: **The Impact of a Decrease in Household Credit Risk**

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.

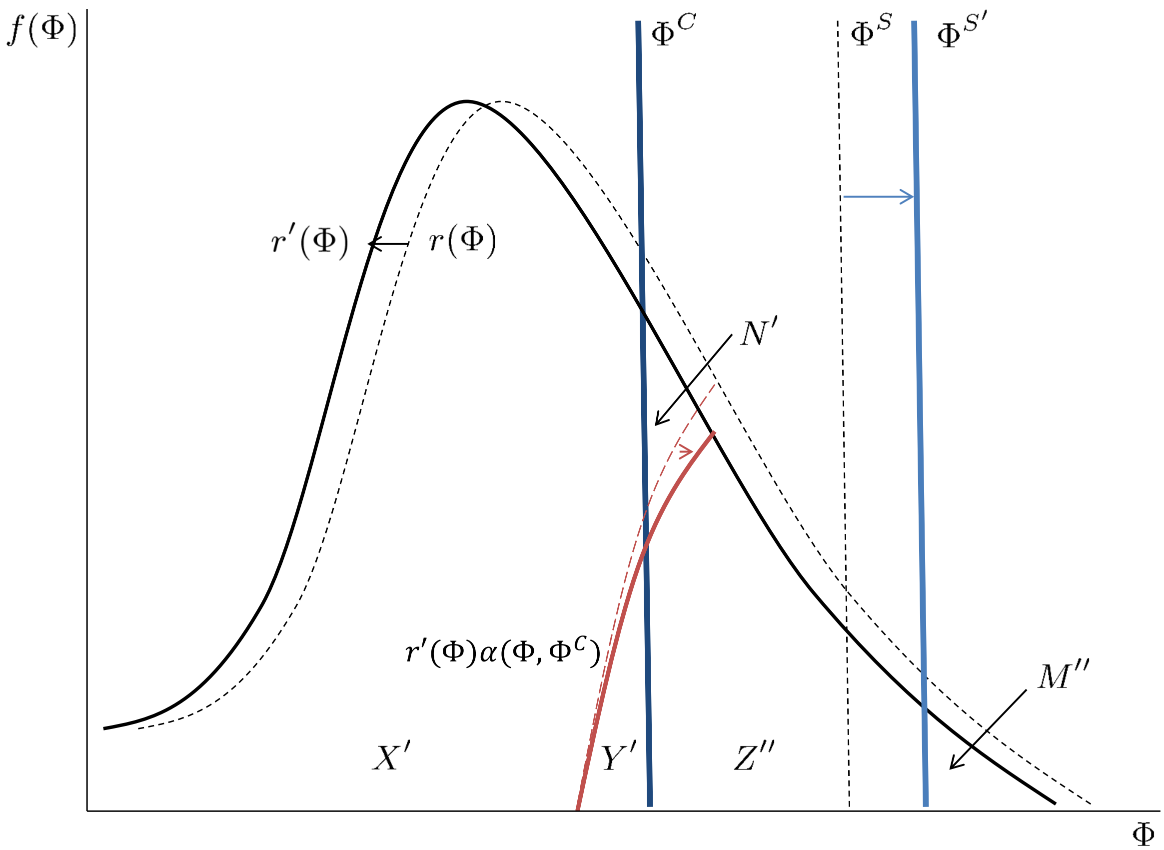

Figure 6: **The Impact of a Decrease in Household Credit Risk and a Relaxation in Subprime Lending Standards**

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.

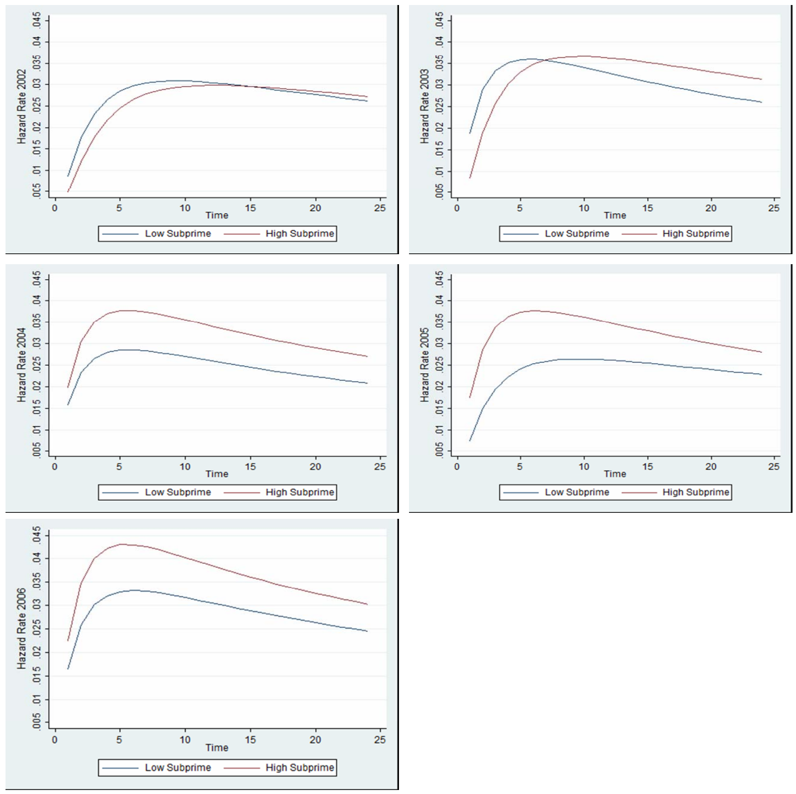

Figure 7: **Lease Hazard Curves in Low and High Subprime MSAs from 2002 to 2006, assuming a lognormal distribution.** (MSAs are classified according to the percentage of purchase subprime mortgages originations from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are those in the 4th quartile.)

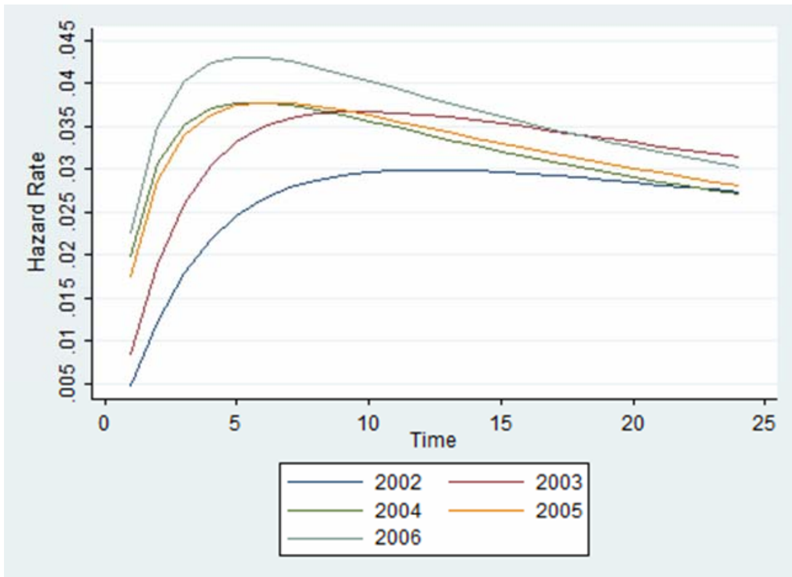

Figure 8: **Evolution of Lease Hazard Curves in High Subprime MSAs, Assuming a Lognormal Distribution.** (MSAs are classified according to the percentage of purchase subprime mortgages originations from 2001 to 2006. Low subprime MSAs are those in the 1st quartile whereas high subprime MSAs are those in the 4th quartile.)

Appendix:

Table A.1: 2001 Cohort MSAs

Num.	*FIPS*	*MSA Name*	*State*
1	12060	Atlanta-Sandy Springs-Marietta	GA
2	13140	Beaumont-Port Arthur	TX
3	16580	Champaign-Urbana	IL
4	16700	Charleston-North Charleston-Summerville	SC
5	16740	Charlotte-Gastonia-Rock Hill	NC
6	17140	Cincinnati-Middletown	OH
7	17900	Columbia	SC
8	19660	Deltona-Daytona Beach-Ormond Beach	FL
9	24860	Greenville-Mauldin-Easley	SC
10	26420	Houston-Sugar Land-Baytown	TX
11	26900	Indianapolis-Carmel	IN
12	27260	Jacksonville	FL
13	28940	Knoxville	TN
14	29820	Las Vegas-Paradise	NV
15	32820	Memphis	TN
16	34940	Naples-Marco Island	FL
17	36420	Oklahoma City	OK
18	36740	Orlando-Kissimmee-Sanford	FL
19	38060	Phoenix-Mesa-Glendale	AZ
20	41700	San Antonio-New Braunfels	TX
21	43780	South Bend-Mishawaka	IN
22	45220	Tallahassee	FL
23	45300	Tampa-St. Petersburg-Clearwater	FL
24	46060	Tucson	AZ

Table A.2: List of MSAs in the Data Sample

No.	FIPS	Name	State
1	11100	Amarillo	TX
2	11460	Ann Arbor	MI
3	11700	Asheville	NC
4	12060	Atlanta-Sandy Springs-Marietta	GA
5	12580	Baltimore-Towson	MD
6	13140	Beaumont-Port Arthur	TX
7	13380	Bellingham	WA
8	13820	Birmingham-Hoover	AL
9	14260	Boise City-Nampa	ID
10	14500	Boulder	CO
11	15180	Brownsville-Harlingen	TX
12	16580	Champaign-Urbana	IL
13	16700	Charleston-North Charleston-Summerville	SC
14	16740	Charlotte-Gastonia-Rock Hill	NC
15	17140	Cincinnati-Middletown	OH
16	17460	Cleveland-Elyria-Mentor	OH
17	17780	College Station-Bryan	TX
18	17820	Colorado Springs	CO
19	17900	Columbia	SC
20	18140	Columbus	OH
21	18580	Corpus Christi	TX
22	19380	Dayton	OH
23	19660	Deltona-Daytona Beach-Ormond Beach	FL
24	19740	Denver-Aurora-Broomfield	CO
25	20500	Durham-Chapel Hill	NC
26	21340	El Paso	TX
27	22180	Fayetteville	NC
28	22380	Flagstaff	AZ
29	23540	Gainesville	FL
30	23580	Gainesville	GA
31	24660	Greensboro-High Point	NC
32	24860	Greenville-Mauldin-Easley	SC
33	26420	Houston-Sugar Land-Baytown	TX
34	26900	Indianapolis-Carmel	IN
35	27260	Jacksonville	FL
36	28020	Kalamazoo-Portage	MI
37	28140	Kansas City	KS
38	28940	Knoxville	TN
39	29460	Lakeland-Winter Haven	FL
40	29620	Lansing-East Lansing	MI
41	29820	Las Vegas-Paradise	NV
42	32820	Memphis	TN
43	33260	Midland	TX
44	33460	Minneapolis-St. Paul-Bloomington	MN

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No.	**FIPS**	**Name**	**State**
45	33700	Modesto	CA
46	33780	Monroe	MI
47	34900	Napa	CA
48	34940	Naples-Marco Island	FL
49	34980	Nashville-DavidsonMurfreesboroFranklin	TN
50	36100	Ocala	FL
51	36420	Oklahoma City	OK
52	36740	Orlando-Kissimmee-Sanford	FL
53	37100	Oxnard-Thousand Oaks-Ventura	CA
54	37340	Palm Bay-Melbourne-Titusville	FL
55	37460	Panama City-Lynn Haven-Panama City Beach	FL
56	37860	Pensacola-Ferry Pass-Brent	FL
57	38060	Phoenix-Mesa-Glendale	AZ
58	38900	Portland-Vancouver-Hillsboro	OR
59	38940	Port St. Lucie	FL
60	39100	Poughkeepsie-Newburgh-Middletown	NY
61	39580	Raleigh-Cary	NC
62	39900	Reno-Sparks	NV
63	40060	Richmond	VA
64	40140	Riverside-San Bernardino-Ontario	CA
65	40220	Roanoke	VA
66	40900	SacramentoArden-ArcadeRoseville	CA
67	40980	Saginaw-Saginaw Township North	MI
68	41500	Salinas	CA
69	41620	Salt Lake City	UT
70	41700	San Antonio-New Braunfels	TX
71	41740	San Diego-Carlsbad-San Marcos	CA
72	41940	San Jose-Sunnyvale-Santa Clara	CA
73	42020	San Luis Obispo-Paso Robles	CA
74	42220	Santa Rosa-Petaluma	CA
75	43780	South Bend-Mishawaka	IN
76	44700	Stockton	CA
77	45220	Tallahassee	FL
78	45300	Tampa-St. Petersburg-Clearwater	FL
79	45780	Toledo	OH
80	46060	Tucson	AZ
81	46140	Tulsa	OK
82	46340	Tyler	TX
83	46700	Vallejo-Fairfield	CA
84	47020	Victoria	TX
85	47260	Virginia Beach-Norfolk-Newport News	VA
86	48660	Wichita Falls	TX
87	49180	Winston-Salem	NC
88	49700	Yuba City	CA