CREDIT BOOMS AND LENDING STANDARDS:

EVIDENCE FROM THE SUBPRIME MORTGAGE MARKET

Giovanni Dell'Ariccia, Deniz Igan, and Luc Laeven[*]

First Version: December 2007
This Draft: February 2008

Abstract

This paper studies the relationship between the recent boom and current delinquencies in the subprime mortgage market. Specifically, we analyze the extent to which this relationship can be explained by a decrease in lending standards that is unrelated to improvements in underlying economic fundamentals. We find evidence of a decrease in lending standards associated with substantial increases in the number of loan applications. We also find that the underlying market structure of the mortgage industry mattered, with larger declines in lending standards being associated with increases in the number of competing lenders. Finally, increased ability to securitize mortgages appears to have affected lender behavior, with lending standards experiencing greater declines in areas with higher mortgage securitization rates. The results are consistent with theoretical predictions from recent financial accelerator models based on asymmetric information, and shed some light on the underlying causes and characteristics of the current crisis in the subprime mortgage market.

I. INTRODUCTION

Recent events in the market for mortgage-backed securities have placed the U.S. subprime

mortgage industry in the spotlight. Over the last decade, this market has expanded

dramatically, evolving from a small niche segment to a major portion of the overall U.S.

mortgage market. Anecdotal evidence suggests that this trend was accompanied, at best, by a

decline in credit standards and excessive risk taking by lenders, and, at worst, by widespread

outright fraud.[1] Indeed, the rapid expansion of subprime lending, fueled by financial

innovation, loose monetary conditions, and increased competition, is seen by many as a

credit boom gone bad. Yet, few attempts have been made to empirically link lending

standards and delinquency rates in the subprime mortgage market to its recent rapid

expansion. To our knowledge, our paper is the first to do so.

How does the recent increase in delinquency rates relate to the boom? How did

lending standards change over the expansion? How did changes in local market structure and

financial innovation affect lender behavior during the boom? What was the role of monetary

policy? To answer these questions, we use data from over 50 million individual loan

applications combined with information on local and national economic variables.

Reminiscent of the pattern linking credit booms with banking crises, current mortgage

delinquencies appear related to past credit growth. In particular, delinquency rates rose more

sharply in areas that experienced larger increases in the number and volume of originated

loans (Figure 1).[2] We find evidence that this relationship is linked to a decrease in lending

---

[1] See, for example, FitchRatings (2007).

[2] Indeed, some have compared the current situation to major financial crises in developed countries and emerging market economies (Reinhart and Rogoff, 2008).

standards, as measured by a decline in loan denial rates and a significant increase in loan-to-income ratios, not explained by an improvement in the underlying economic fundamentals. In particular, consistent with recent theories,[3] the size of the boom mattered. Denial rates declined more and loan-to-income ratios rose more in areas that experienced larger increases in the number of loan applications.

While limited to a relatively narrow segment of the market, the subprime boom did share other characteristics often associated with aggregate boom-bust credit cycles; these include financial innovation (securitization), changes in market structure, fast rising house prices, and ample aggregate liquidity. We find evidence that all these factors were associated with the decline in lending standards. Denial rates declined more in areas with a larger number of competitors and were further affected by the entry into local markets of large financial institutions. The increasing recourse to loan sales and asset securitization appears to have affected lender behavior, with lending standards experiencing greater declines in areas where lenders sold a larger proportion of originated loans. Lending standards declined more in areas with more pronounced housing booms, including when controlling for simultaneity biases. Finally, easy monetary conditions seem to have played a role, with the cycle in lending standards mimicking that in the Federal Fund rate. In the subprime mortgage market most of these effects appear to be stronger and more significant than in the prime mortgage market, where loan denial decisions seem to be more closely related to economic fundamentals.

We obtain this evidence in an empirical model where, in addition to taking into account changes in macroeconomic fundamentals, we control for changes in the distribution

---

[3] See the next section for a brief review of the literature.

of applicant borrowers and for the potential endogeneity of some of the explanatory variables. Specifically, we develop a two-stage regression framework, explained in detail later on, that exploits individual loan application data to control for changes in the quality of the pool of loan applicants. We focus on loan applications rather than originations to reduce further the concern for simultaneity biases. For further robustness, we run an instrumental variable specification of our model, where we instrument the subprime applications variable with the number of applications in the prime market.

The contribution of this paper is threefold. First, the paper establishes a link between credit growth (and the growth in the number of originated loans) and lending standards in the subprime mortgage market. This result sheds some light on the origins of the current crisis in the mortgage industry. In particular, it shows that factors such as an increased recourse to loan sales and changes in the structure of local credit markets may have amplified the decline in denial rates and the increase in loan-to-income ratios, lending some support to the notion that securitization may have had a dampening effect on bank screening incentives.

Second, the boom-bust cycle of the subprime mortgage market, beyond being of interest in itself, provides an excellent "lab case" to study credit booms in general. Indeed, the wealth of information available for this market allows us to control for several factors, such as changes in the pool of loan applicants, that are difficult to take into account when studying episodes of aggregate credit growth.

Third, the paper lends empirical support to recent theories linking credit booms and lending standards. In that context, the subprime mortgage market provides an almost ideal testing ground for theories of intermediation based on asymmetric information (and adverse selection in particular). Indeed, subprime borrowers are generally riskier, more

heterogeneous, can post less collateral, and have shorter or worse credit histories (if any) than their prime counterparts.

From a policy standpoint, this paper contributes to the debate on the potential dangers associated with credit booms. There appears to be widespread agreement that periods of rapid credit growth tend to be accompanied by loosening lending standards. For instance, in a speech delivered before the Independent Community Bankers of America on March 7, 2001, former Federal Reserve Chairman Alan Greenspan pointed to "an unfortunate tendency" among bankers to lend aggressively at the peak of a cycle and argued that most bad loans were made through this aggressive type of lending.[4] In line with this common view, several studies provide empirical evidence on the cyclicality of lending standards (see below). This paper builds on that literature while focusing on the subprime mortgage market. In addition to documenting the effects of credit booms on lending standards, evidence in this paper suggests that during these episodes banks' risk-taking may be excessive to the extent that standards decline more than justified by economic fundamentals. Finally, this paper provides hints on the potential effects of monetary policy on banks' risk-taking, with low interest rates affecting lending standards both directly and through their effect on real estate prices.[5]

The rest of the paper is organized as follows. Section II reviews the related literature. Section III provides a description of the data and introduces some stylized facts. Section IV describes our empirical methodology. Section V presents the results. Section VI concludes.

---

[4] See also Caruana (2002), Ferguson (2004), and Bernanke (2007).

[5] See Jimenez et al. (2007) for recent evidence on the effects of monetary policy on bank risk-taking.

II. RELATED LITERATURE

The literature on subprime lending largely focuses on issues of credit access and discrimination. Munnell et al. (1996) use loan level data from the Boston area and find that race has played an important, although diminishing, role in the decision to grant a mortgage. Our specification for loan level regressions is based on their paper. A second group of papers studies the determinants of lending decisions and delinquency rates of subprime lenders. Pennington-Cross (2002), using data on both primary and secondary mortgage markets, finds that subprime lenders predominantly make loans in metropolitan statistical areas with weak economic fundamentals and are more likely to keep loans on their balance sheets in such locations when economic fundamentals are improving. In a recent paper, Demyanyk and Van Hemert (2007) employ a loan-level database on securitized subprime loans and find that delinquency and foreclosure rates of subprime borrowers are to a large extent determined by high loan-to-value ratios. Our paper is also related to the broader literature on the determinants of mortgage choice and delinquencies (see, e.g., Von Furstenberg and Green, 1974; Deng et al. 2000; Campbell and Cocco, 2003; and Cutts and Van Order, 2005).

Several studies provide empirical evidence on the cyclicality of lending standards. Asea and Blomberg (1998) show that the probability that a loan is collateralized increases during contractions and decreases during expansions. Lown and Morgan (2003) find that lending standards tighten as the level of loans made in previous periods increase. Jimenez and Saurina (2006) present evidence that, during booms, riskier borrowers obtain funds and collateral requirements decrease.

Most theoretical frameworks explaining procyclical variation in credit standards rely on business cycle factors,[6] since rapid credit episodes generally take place during upturns rather than in recessions. For instance, Bernanke and Gertler (1989) assert that, in the downward phase of the business cycle, firms' net worth declines, which increases the agency costs lenders have to deal with, and hence, leads to fewer loans and higher markups on credit. Following a similar argument, Kiyotaki and Moore (1997) show that rising asset prices may ignite a lending boom by increasing collateral values. When the asset price cycle starts coming down from its peak and the collateral values decrease, defaults begin.[7] Rajan (1994) suggests that herd behavior by bank managers can also feed a rapid growth spiral: short-sighted managers choose to behave like their peers as losing market share hurts their job prospects through reputation effects, and mistakes are punished more leniently when they are common across the banking sector. By linking changes in lending standards to increases in the number of loan applicants, our paper also lends some empirical support to a slightly different and complementary view. Berger and Udell (2004) show that banks find it harder to recruit experienced and qualified loan officers to keep up with the rapid pace of loan applications, leading to deterioration in loan processing and risk assessment procedures and a decline in bank profitability. Dell'Ariccia and Marquez (2006) argue that incentives to appropriately screen borrowers are weaker when large numbers of new applicant borrowers reduce the adverse selection stemming from informational asymmetries among lenders. This is reflected as a reduction in lending standards, which in turn increases vulnerability to

---

[6] See Ruckes (2004) and Dell'Ariccia and Marquez (2006), and references therein, for more details on theories of procyclical credit standards.

[7] Matuyama (2007) shows that due to capital market imperfections changes in borrower net worth can shift the composition of bank credit between projects with different productivity levels and such endogenous changes in investment technologies in turn affect borrower net worth, potentially resulting in credit cycles and collapse.

financial distress when the economy experiences a downturn. Finally, in Gorton and He (2003), fluctuations in lending standards arise from strategic interaction among asymmetrically informed banks, in a model of cartel behavior related to that in Green and Porter (1984).

III. DATA AND PRELIMINARY ANALYSIS

A. Data Description

We combine data from several sources. Our main set of data consists of economic and demographic information on applications for mortgage loans. We use additional information on local and national economic environment and on home equity loan market conditions to construct our final data set.

The individual loan application data come from the Home Mortgage Disclosure Act (HMDA) Loan Application Registry. Relative to other sources, including LoanPerformance and the Federal Reserve Bank's Senior Loan Officer Opinion Survey, this dataset has the important advantage of covering extensive time-series data on both the prime and subprime mortgage markets. The availability of data on the prime mortgage market provides us with a control group generally unavailable to studies focusing on aggregate credit. By comparing prime mortgage lenders and subprime mortgage lenders we are also able to identify different characteristics of the two lending markets, including differences in the evolution of lending standards over our sample period. Given the different risk profiles of the prime and subprime markets, we include variables that proxy for the risk characteristics of a loan application to enhance comparability of the results across the two markets.

Enacted by Congress in 1975, HMDA requires most mortgage lenders located in metropolitan areas to collect data about their housing-related lending activity and make the data publicly available. The purpose of the Act was two-fold: enhance enforcement of anti-discriminatory lending laws and provide public and private investors with information to guide investments in housing. Initially, only originated and purchased home loans by geographic location were required to be reported under the HMDA. Yet, in order to fulfill the purposes of the HMDA better, the data requirements were expanded twice: in 1989, to include information on denied loan applications as well as the race, sex, and income of the applicant, and in 2002, to add new fields including lien status and price data for some loans.[8]

The HMDA covers a large set of depository and nondepository financial institutions. Whether an institution is covered depends on its size, the extent of its activity in a metropolitan statistical area (MSA), and the weight of residential mortgage lending in its portfolio. Any depository institution (bank, credit union, savings and loan, thrift) with a home office or branch in an MSA must report HMDA data if it has made a home purchase loan on a one-to-four unit dwelling or has refinanced a home purchase loan and if it has assets above an annually adjusted threshold. Any nondepository institution (i.e., a mortgage company that does not accept deposits but raises funds for lending by borrowing from banks or capital markets) with at least ten percent of its loan portfolio composed of home purchase loans must also report HMDA data if it has assets exceeding $10 million. Under these criteria, small lenders and lenders with offices only in non-metropolitan areas are exempt from HMDA data reporting requirements. Therefore, information for rural areas tend to be

---

[8] Lien status is not reported for purchased loans and only originated loans with spreads exceeding designated thresholds are required to have price information.

incomplete. Yet, Census figures reveal that 82.6 percent of the population in 2000 and 83.2 percent of the population in 2006 lived in metropolitan areas, and hence, the bulk of residential mortgage lending activity is likely to be reported under the HMDA. Comparisons of the total amount of loan originations in the HMDA and industry sources indicate that around 90 percent of the mortgage lending activity is covered by the loan application registry (Table 1).

Our coverage of HMDA data starts from 2000 and ends in 2006. This roughly corresponds to the picking up of both the housing boom and the rapid subprime mortgage market expansion (Figure 2). HMDA data does not include a field that identifies whether an individual loan application is a subprime loan application. In order to distinguish between the subprime and prime loans, we use the subprime lenders list as compiled by the U.S. Department of Housing and Urban Development (HUD) each year. HUD has annually identified a list of lenders who specialize in either subprime or manufactured home lending since 1993. HUD uses a number of HMDA indicators, such as origination rates, share of refinance loans, and proportion of loans sold to government-sponsored housing enterprises, to identify potential subprime lenders. It is important to keep in mind, however, that not all loans reported by designated subprime lenders are subprime and, similarly, not all loans reported by prime lenders are prime.

Starting in 2004, lenders are required to identify loans for manufactured housing and loans in which the annual percentage rate (APR) on the loan exceeds the rate on the Treasury security of comparable maturity by at least three (five, for second-lien loans) percentage points and report this information to the HMDA. The rate spread variable could in principle also be used as a screen to identify potential subprime lender specialists (in addition to the

HUD list). In fact, for the years that we have data on both rate spread information and the

HUD ranking of subprime lenders, we find as expected that the ranking of subprime lenders

using the rate spread variable alone coincides closely with the ranking in the HUD list.[9]

Given that we do not have information on rate spreads prior to 2004, we prefer to use the

HUD ranking to identify subprime lenders. The HUD list of subprime lenders is also

preferable to the rate spread information for a number of other reasons. First, subprime loans

do not necessarily have APRs that are three (or five) percentage points above a comparable

Treasury rate. Second, when inquired about the large proportion of high-APR loans in their

portfolio, some lenders have stated that their APR information was incorrectly reported.

Third, a number of lenders are multi-purpose lenders and their large proportion of loans with

spreads above the designated thresholds are due to their broker channels. Fourth, high-APR

loans are not necessarily subprime loans but instead may reflect fees and yield spread

premiums. Fifth, the designation of a loan with an APR above a comparable Treasury

security is dependent on the yield curve. Sixth, the rate spread in HMDA is required to be

reported only for originated loans, making it uninformative when it comes to distinguishing

between prime and subprime applications and calculating denial rates for the two types

separately.

       We remove some observations with missing HMDA data from the sample and also

focus on the subset of loans that are either approved or denied. First, we drop applications

with loan amounts smaller than 1,000 dollars because loan values are expressed in units of

thousands of dollars and rounded up to the nearest number. Second, applicant income is left-

censored at a value of 10,000 dollars. We therefore eliminate applicants with missing

---

[9] The correlation is around 0.8.

applicant income or applicant income of exactly 10,000 dollars. Third, we drop loans for multi-family purpose from the sample, as this is a distinct market from the overall mortgage market for single family homes. Fourth, we drop federally insured loans from the sample. Finally, and importantly, we eliminate all application records that did not end in one of the three following actions: (i) loan originated, (ii) application approved but loan not originated, or (iii) application denied. Other actions represent dubious statuses (e.g. application withdrawn by applicant) or loans purchased by other financial institutions. Including purchased loans would amount to double-counting as these loans are reported both by the originating institution and the purchasing institution.

We supplement the information from the HMDA using data on economic and social indicators at the MSA level published by the federal agencies and private industry research companies, including annual data on macroeconomic variables, such as personal income, labor and capital remuneration, self-employment, and population from the Bureau of Economic Analysis (BEA), data on unemployment and inflation (Consumer Price Index) from the Bureau of Labor Statistics (BLS), data on total population from the Census Bureau, and data on house price appreciation in a given MSA (based on a quarterly Housing Price Index) from the Office of Federal Housing Enterprise Oversight (OFHEO). We also obtain data on "seriously delinquent" subprime loans, defined as subprime loans with 60 or more days delay in payment, from LoanPerformance, a private company. Data on these delinquency rates are available only for 2004 onwards.

Table 2 presents the name and definitions of the variables we use and the data sources. Table 3 presents the sample period summary statistics of these variables at the loan application and MSA levels. The data cover a total of 387 MSAs for a period of 7 years

(2000 to 2006), amounting to a total of 2,709 observations. In 2003, the US Office of

Management and Budget introduced a new classification of MSAs. We use the 2003

classification of MSAs throughout the sample period to map individual loans to MSAs.

Where necessary, the boundaries of the MSAs were changed to reflect this new definition.

For the entrant and incumbent variables, summary statistics are based on data for the period

2001 onwards only, as entry data is missing for the first year of the sample period. The

summary statistics show that about one in five loan applications is denied, while about one-

fourth of all loans are extended by subprime lenders. The average loan amount is 160

thousand dollars, average applicant income is about 80 thousand dollars, and the average

loan-to-income ratio of applicants is about 4. A significant share of loans, about 60 percent in

total, is used for refinancing purposes, while very few loans (about half a percent of total

loans) are extended to households with income below the poverty line applicable in the year

of application. Finally, as expected, the denial rate of subprime lenders is much higher (about

2.5 times) than the denial rate of prime lenders.

B.   Preliminary Analysis

In the most general definition loans available to "riskier" individuals that do not meet

industry-wide prime underwriting guidelines are classified as subprime. Typically, three

groups of products, because of borrower and loan characteristics, fall into this category: (i)

loans targeted to borrowers with poor or blemished credit histories; (ii) loans originated with

no or little documentation of the underwriting information (also known as "Alt A" loans);

and (iii) loans with high loan-to-value ratios (which in most cases are refinancing loans).

Industry publications suggest that the first of these groups, credit-impaired lending, constitute the majority of the subprime mortgage market.[10]

Over the last decade, subprime mortgage lending has evolved from a small niche to a major portion of the overall home equity market, through a quick expansion of both the number of loans originated and the average loan amount. Subprime mortgage originations almost tripled since 2000, reaching $600 billion in 2006. Against an also fast growing market for prime mortgages, this boom brought the share of subprime lending from 9 percent in 2000 to 20 percent of all mortgage originations and to 13.7 percent of total outstanding mortgage loans in 2006. Average loan amount also grew reaching $132,784 or 90 percent of the prime mortgage average amount. In absolute terms, the subprime market is worth approximately $1.3 trillion.

A complete analysis of the factors driving the rapid expansion of the subprime market is beyond the scope of this paper. That said, there are indications that the boom was related to both economic conditions and the regulatory environment. First, the unprecedented long and strong housing boom, supported by steady income growth and easy monetary conditions,[11] fed both the lenders' and borrowers' appetite for risk. As the value of the underlying asset kept on rising, incentives to take on more leverage increased, while more and more investors entered the market. With the median home price well above the limit for conforming loans and government-backed loans for low-income borrowers in many regions,[12] private lenders

---

[10] The Mortgage Market Statistical Manual for 2000, published by Inside Mortgage Finance, suggests that three quarters of all subprime loans are originated to borrowers with credit scores around or below 600. For comparison, nearly 60 percent of prime borrowers have credit scores above 720.

[11] See Case and Shiller (2004) and Himmelberg, Mayer, and Sinai (2005).

[12] As of 2006, 38 percent of metropolitan areas had single-family home median sales price exceeding the FHA loan limit, according to data provided by the National Association of Realtors.

found a large pool of potential borrowers looking for loans that could be obtained under less stringent requirements (subprime lenders have been often willing to approve loans with no or very low down payments and reduced or no documentation of income and assets).

Innovations in the underwriting techniques and the secondary market lowered the cost of origination and funding for subprime loans. In the mid 1990s, technological advancements let lenders adopt automated underwriting procedures, substituting loan officer judgment with numerical credit scores in the assessment of borrowers' creditworthiness, which also allowed claims of discrimination to be refuted more easily because of the added anonymity. These changes, in turn, let lenders use risk-pricing more effectively. In addition, with the explosive growth of asset-backed securities, subprime lenders were able to market and sell their loans, and hence, have better access to capital markets and spread risk more broadly. Lastly, large banks such as Wells Fargo and Citicorp formed their own subprime operating subsidiaries and entered this fast growing and less tightly regulated market.[13]

What brought most of the attention into this booming market was the increase in delinquency rates. The question we ask is whether the current deterioration in delinquencies is linked to past credit growth and, if so, whether there is evidence of easing credit standards that could explain such a link between delinquencies and credit growth. In other words, is the current subprime mortgage crisis a boom gone bad? Do lenders behave differently in booming markets and what market characteristics affect their behavior?

---

[13] The mortgage industry is regulated at both the state and federal levels. Many of the strongest and most important consumer protection laws have been enacted by the states and are enforced by state regulators. In a recent Supreme Court decision, namely, the case of *Watters vs Wachovia Bank*, the Office of the Comptroller of the Currency, the regulator for national banks, was ruled to have exclusive regulatory authority over national banks' state-chartered mortgage operations. Hence, a primary advantage for a national bank to maintain operating subsidiaries as separate corporations is that this structure shields the bank from the subsidiaries' liabilities while avoiding compliance with state mortgage lending regulations.

A first look at our data suggests that rapid growth in subprime loan volume was associated with a decrease in denial rates on subprime loan applications and an increase in the loan-to-income ratio on the loans originated by subprime lenders (Figure 3). These casual observations lend some support to the view that lending decisions are influenced by market conditions and rapid credit growth episodes tend to beget trouble later on. In the next sections, we explore these relations in a more formal setting.

IV. EMPIRICAL METHODOLOGY

In this section, we examine whether, during the recent boom, banks have become less choosy in how they grant loans. Because of data limitations, we rely on two main indicators of lending standards: the application denial rate and the loan to income ratio. We focus primarily on regressions at the MSA level. We control for changes in the economic environment in the MSA by including variables that have been shown to be good predictors of loan denial decisions at the individual level (see Munnell et al., 1996), such as average income, income growth, the unemployment rate, and the self-employment rate. We include a measure of house price appreciation to take into account the role of collateral. The number of competing lenders is a proxy for the competitive conditions in the MSA. Finally, we include the number of loan applications as a measure of credit expansion. We find this variable preferable to the number of loans originated or the growth in credit volume as it is arguably less endogenous to the dependent variable (i.e., denial rates). Endogeneity may remain a concern to the extent that potential borrowers might be deterred from applying for a loan if denial rates are generally high in their area. For this reason, we also estimate an instrumental variable specification of the model (details later in the paper). In addition, we control for

time-invariant MSA specific factors and for time-variant nationwide-uniform factors by

including MSA and time fixed effects.

We estimate the following linear regression model:

$$DR_{it} = \alpha_t + \gamma_i + \beta_1 AVGINC_{it} + \beta_2 INCGROW_{it} + \beta_3 UNEMP_{it} + \beta_4 SELFEMP_{it} + \beta_5 POP_{it} +$$

$$\beta_6 COMP_{it} + \beta_7 HPAPP_{it-1} + \beta_8 APPL_{it} + \varepsilon_{it}, \hspace{3cm} \text{(Eq. 1)}$$

where DR_{it} is the average denial rate of mortgage loan applications for home purchase and

refinance purposes in MSA i in year t. It is computed as the number of loan applications

denied divided by the total number of all loan applications in a given MSA using loan-level

data at individual banks, and hence, takes on values between 0 and 1.[14] All explanatory

variables are also measured at the MSA level. $AVGINC$ denotes average income, $INCGROW$

is income growth, $UNEMP$ is unemployment rate, $SELFEMP$ is self-employment rate, POP

is the log of total population, $COMP$ is the number of competing lending institutions, $HPAPP$

is the annual change in house price appreciation, and $APPL$ is the log of the number of loan

applications. The error term ε_{it} has the standard properties. Table 2 provides more detailed

definitions and sources of the regression variables. MSA and time fixed effects control for

time-constant regional idiosyncrasies and nationwide changes in economic conditions. The

first five variables are meant to control for the general economic and demographic conditions

in the MSA. We expect areas with higher per capita income and income growth to have

lower denial rates; areas with higher unemployment rates and larger proportions of self-

employed people (whose income may be considered less stable) to have higher denial rates;

and areas with larger populations, proxying for market size, to have lower denial rates.

---

[14] We estimate regression equation 1 using ordinary least squares as well as using truncated regression methods. The results remain the same.

The number of competing lenders in the MSA is meant to capture the effects of competition on lending standards. Since theory does not deliver unambiguous predictions, we do not have a strong prior on the sign of this coefficient.[15] The house price appreciation variable is computed over the same period as the denial rates, although the results are not sensitive to using one-period lagged changes in house price appreciation. We expect this variable to have a negative coefficient. Price increases raise the net worth of borrowers, reducing their default risk. At the same time, lenders may gamble on a continued housing boom to evergreen potentially defaulting borrowers. Finally, our working assumption is that if banks did not change their lending standards during the boom, the variable measuring credit expansion should not be statistically significant after controlling for the other factors affecting the banks' decision. If instead banks lent more leniently in regions and times of fast credit expansion, we should find a negative and significant coefficient for this variable. In that case, we would have established a link between credit expansion and loan quality that, in turn, would explain why we now observe higher delinquency rates in regions that experienced greater booms.

Theoretical models focusing on adverse selection (such as Broecker, 1990, and Riordan 1993) predict that an increase in the number of competing lenders in a market may have the perverse effect of increasing lending interest rates and make banks more choosy (tighten standards). However, it has also been argued that, when local borrowers have an informational advantage, the threat of new entry may induce incumbents to cut standards and trade loan quality for market shares. We test for these effects by focusing on the behavior of incumbent lenders when large nationwide institutions entered local markets. To that purpose

---

[15] See Dell'Ariccia and Marquez (2006) for a discussion of this issue.

we augment the model in equation (1) with a variable measuring the market share of new entrants that belong to the top 20 lending institutions in the country (in either prime mortgage markets, subprime mortgage markets, or both). We compute the market share in terms of number of loan applications, not originations, to limit concerns about endogeneity. We expect the coefficient on the entrants variable to be negative since we already control for the adverse selection effect considered by Broecker (1990), among others, with the number of competing lenders in the region.

For robustness purposes, we construct an alternative denial rate-based measure of lending standards. We borrow and augment the empirical model presented in Munnell et al. (1996) to estimate bank's loan approval decision with individual application data, though we do not have data on all variables considered by Munnell et al (1996). Specifically, we do not have data on borrower credit scores. We augment the specification in Munnell et al. (1996) by including several new variables, including whether or not the loan is being used for refinancing purposes and whether or not the household income of the loan applicant is below the poverty line (as applicable in the year of loan application). We expect the latter to be particularly important in the case of subprime loans because applicants for subprime loans tend to have low income. We estimate the following logit specification at the loan application level for the year 2000:

$$D_{jk} = \alpha_k + \gamma_1 INC_j + \gamma_2 LIR_j + \gamma_3 POV_j + \gamma_4 REFIN_j + \gamma_5 OCC_j + \gamma_6 F_j + \gamma_7 B_j + \gamma\beta_8 W_j + \varepsilon_{jk},$$

(Eq. 2)

where j denotes loan application j, k denotes lender k, α_k denotes lender specific fixed effects, and D_{jk} is a dummy variable that takes a value of one if lender k denied loan application j in year 2000, and zero otherwise. All explanatory variables are measured at the loan application

level. *INC* is applicant income, *LIR* is the loan-to-income ratio, *POV* is a dummy variable

denoting whether or not the applicant income is below the poverty line for a family of four,

REFIN is is a dummy variable denoting whether or not the purpose of the loan is to refinance

an existing loan, *OCC* is a dummy variable denoting whether or not the property financed by

the loan is intended for owner occupancy, *F* is a dummy variable indicating whether or not

the applicant is female, *B* is a dummy variable indicating whether or not the applicant is

black, and *W* is a dummy variable indicating whether or not the applicant is white (the

default option being of Hispanic origin). Table 2 provides more detailed definitions and

sources of the variables. Next, we use the estimate coefficients of Regression (2) to forecast

the denial rate for mortgage applications in subsequent years, and aggregate the residuals of

this regression at the MSA level. Finally, we use this constructed measure of prediction

errors as the dependent variable for our main model. The advantage of this two-stage

regression approach over using simple, unadjusted denial rates is that it takes into account

changes in the pool of applicant borrowers that are difficult to control for at the MSA level.

As an alternative measure of lending standards, we consider the average loan-to-

income ratio in the MSA. Other things equal, an increase in this ratio would signal a looser

attitude in banks' decisions to grant loans. We estimate the following regression model:

$$LIR_{it} = \alpha_t + \gamma_i + \beta_1 AVGINC_{it} + \beta_2 INCGROW_{it} + \beta_3 UNEMP_{it} + \beta_4 SELFEMP_{it} + \beta_5 POP_{it} +$$

$$\beta_6 COMP_{it} + \beta_7 HPAPP_{it-1} + \beta_8 APPL_{it} + \varepsilon_{it}, \tag{Eq. 3}$$

where the set of explanatory variables is the same as in regression model 1.

Our final set of regressions are aimed at measuring the effect of securitization on

bank lending decisions. The specifications presented above are augmented with a variable

measuring the percentage of loans in an MSA that are sold within a year from origination.

According to the view that securitization causes moral hazard in loan originators, we should find that lending standards are looser (lower denial rates and higher loan-to-income ratios) in MSAs with higher securitization rates.

V. EMPIRICAL FINDINGS

We find robust evidence that lending standards eased in the subprime mortgage industry during the fast expansion of the past few years. After controlling for economic fundamentals, lenders appear to have denied fewer loan applications and to have approved larger loans. Table 4 reports the results for the denial rate regression, where we control for MSA fixed effects. Column (1) reports results for all lenders, while columns (2) and (3) report results separately for either only prime lenders or subprime lenders (where subprime lenders are defined according to the annual list compiled by the HUD). This sample breakdown between prime and subprime lenders allows us to identify different characteristics of the two lending markets, including differences in the evolution of lending standards. Most coefficients have the expected sign. Starting from our main variables of interest: a faster rate of house price appreciation was associated with lower denial rates. This, as discussed before, is consistent with the notion that lenders were to some extent gambling on speculative borrowers, but may also reflect the positive effect of higher borrower net worth on creditworthiness. Notably, this effect was much more pronounced in the subprime relative to the prime mortgage market where both these factors are likely to be more relevant. Denial rates in both markets are also lower in MSAs where applicants tend to have higher income. In the subprime mortgage market, denial rates were lower in more competitive markets as measured by the number of competitors in the MSA. This coefficient was, instead, not statistically significant for the

prime market. In the subprime mortgage market, the denial rate was also negatively and significantly associated with the number of loan applications in the MSA. Given that we are including MSA fixed effects and thus effectively estimating regressions in first differences, this result suggests that the lending boom (as captured by changes in the number of applications) was associated with a reduction in lending standards (as captured by changes in denial rates). In the prime market, however, denial rates are positively and significantly associated with the number of applications, consistent with the notion that the lending standards in the prime market were tightened as applications grew. This suggests different credit boom dynamics in these two markets. In the subprime market, the decline in standards associated with the rise in the number of applications is consistent with what predicted by theories of intermediation where asymmetric information among lenders plays an important role. In the prime market, the publicly available credit history of borrowers makes these frictions less likely to be relevant, and the tightening of standards in reaction to a growing numbers of applications may reflect an expected deterioration in the quality of the pool of applicants. Indeed, the coefficient for the prime market loses significance when we control for changes in the characteristics of the applicant pool (see below).

The rest of the control variables have the expected sign, but are generally not significant.

The finding that denial rates are negatively associated with the number of competitors only in the subprime mortgage, and not in the prime mortgage market, also suggests that the decrease in lending standards was associated with different forces in the prime and subprime mortgage markets. Again, in the subprime market, the evidence is consistent with a decline in standards linked to lenders' strategic interaction under asymmetric information and speculative behavior. In contrast, for the prime market, it is more difficult to reject the

hypothesis of a fundamental-driven decline in lending standards. This is consistent with our prior that, relative to fundamentals, the deterioration in lending standards was more pronounced in the subprime mortgage market where the class of borrowers tends to be riskier than in the prime market.

A comparison of year effects across the different specifications shows that denial rates decreased until the end of 2002 and then increased from 2003 onwards, though only in the prime mortgage market. In the subprime mortgage market, after controlling for other factors, denial rates did not vary much over the period 2002 to 2006. Following several years of low interest rates, the U.S. started tightening monetary policy in 2005 by increasing interest rates. While denial rates in the prime mortgage market closely mimic the evolution of interest rates in the U.S., with denial rates increasing sharply in 2005 compared to 2004, this is not the case for the subprime market, where denial rates do not increase in 2005 compared to 2004 (although they do increase somewhat in 2006). This suggests that, while in the prime market monetary policy changes reflected quickly in the denial rate likely through their effect on loan affordability,[16] this did not happen for subprime mortgages, where they likely acted only with substantial lags through changes in house prices. Indeed, a regression specification replacing the year fixed effects with the Federal Funds rate returned a positive coefficient for the prime market, but not for the subprime.[17]

The economic effect of our main findings is substantial. From regression (3) in Table 4, it follows that changes in the number of loan applications (a proxy for credit expansion)

---

[16] This is also consistent with the idea of a negative relationship between bank risk-taking and the monetary policy rate. This hypothesis is explored at length, though in a different context, in Jimenez et al. (2007).

[17] These regression results are not presented for sake of brevity but are available upon request.

have a particularly strong effect on denial rates in the subprime market. For example, a one standard deviation increase in the log of the number of applications reduces MSA-level denial rates of subprime lenders by 4 percentage points, which is substantial compared to a standard deviation of subprime denial rates of 8 percentage points. The effect of applications on denial rates is significantly more negative in the subprime market than in the prime market. In fact, the effect is positive and significant in the prime market. A one standard deviation increase in the number of competitors reduces MSA-level subprime denial rates by 3 percentage points, slightly smaller than the effect of applications though still substantial. For the prime market, we obtain no significant relationship between denial rates and the number of competitors. Finally, a comparison of coefficients across regressions (2) and (3) shows that a one standard deviation increase in house price appreciation reduces MSA-level denial rates by 2 percentage points in the subprime market compared to only 1 percentage point in the prime market. While both effects are not insignificant given a standard deviation of denial rates of 8 percent in the subprime market and 7 percent in the prime market, this indicates that denial rates in the subprime market are more sensitive to house price appreciation.

A. Effects of Changes in the Pool of Applicant Borrowers

Changes in the pool of applicant borrowers not captured by aggregate controls could partly explain our findings on the association between the number of applications and denial rates. The results, however, are broadly the same when, following the two-step approach described above, we control for changes in the underlying borrower population using data on individual borrower characteristics.

To this end, we first identify in Table 5 which characteristics are likely to explain the decision on a loan application. We follow earlier studies on mortgage lending to form a list of variables that would account for the economic factors that might shape the financial institution's decision.[18] These regressions are based on a sample of close to 5 million loan applications in 2000, and include lender-specific fixed effects. The regression coefficients presented in Table 5 are odds ratios. We find that loan applications are more likely denied if borrowers have low income, though this effect is only significant in the prime mortgage market. Applications with higher loan-to-income ratios, denoting riskier loans, are more likely denied in the subprime mortgage market, as expected, though we find the opposite effect in the prime mortgage market. Taken together, these results indicate that applicant income affects lending decisions in a nonlinear fashion, and differently in prime and subprime markets. This is in part because applicants with higher incomes, who primarily apply for prime loans, also tend to apply for larger loans. Loan applications are also more likely denied for male applicants in the subprime market and for female applicants in the prime market, while applications of African-American descent are more likely denied in both markets (as compared to white applicants or applicants of Hispanic descent). White applicants also appear to be less likely denied a mortgage in the prime market. Finally, loan applications for refinancing purposes are more likely denied, while owner occupation does not significantly affect the loan denial decision.

Next, we estimate the regression model with the MSA-level aggregated prediction errors from the model estimated in Table 5 as dependent variable. The results of these regressions (all of which include MSA fixed effects) are reported in Table 6. These results,

---

[18] See Munnell et al. (1996) and references therein.

where we abstract from certain borrower characteristics that determine a lender's decision on a loan application, are broadly consistent with the findings in Table 4. Again, we find that denial rates in both prime and subprime markets tend to deteriorate more in areas with a stronger acceleration in house price appreciation. Subprime denial rates also respond negatively to an increase in competition, as measured by an increase in the log of the number of competitors, and to an increase in the number of loan applications, capturing the expansion of the credit market.

B. Identification Issues

One should be careful in interpreting the estimated coefficients as causal relationships. As proxy for credit market expansion, the loan application series has arguably a smaller endogenous component than the loan originations series. That said, at least in theory, there remains some potential for reverse causality to the extent that potential borrowers may be deterred from applying for a loan if denial rates are generally high in their locale. While our focus on total applications (rather than applications in the subprime market only) partly assuages the potential for an endogeneity bias, for further robustness we estimate an instrumental variable (IV) specification of our model. In this particular specification, we use the log of applications in the subprime market as our main regressor, but we instrument it with the log of the number of prime applications. These two series are highly correlated (the correlation coefficient is over 0.8), while, at least in theory, there should not be a direct negative link between the denial rate in the subprime market and the number of applications in the prime market. If anything, this relationship should be positive, as higher denial rates in the subprime market would make the prime market more attractive. Indeed, the correlation

between the denial rates in the subprime and prime markets in our sample is only about 0.1, suggesting that denial rates in both markets are largely independent from one another. For comparison purposes, we also include the OLS regression of the specification that includes the number of applications in the subprime market. These OLS and IV results are presented in columns (1) and (2) of Table 7. The IV estimates broadly confirm our earlier results, suggesting that our findings are not the product of an endogeneity bias. The F-test of excluded instruments supports the choice of our instrument. The evidence supports the notion of a negative causal link between an increase in the number of applications and denial rates in the subprime market.

Similarly, house price changes may be affected by lending standards to the extent that a decline in standards and an increase in the local supply of mortgages leads to an increase in demand for housing. To address this concern, we consider a specification where we lag the house price variable one period. The results, presented in column (3) of Table 7, confirm our earlier findings that denial rates are negatively affected by (lagged) house price appreciation. Admittedly, some concern about endogeneity between denial rates and house price appreciation remains since, while lagged house price changes are not directly affected by lending standards, it is conceivable that the expectation of a decline in standards, and hence, of an increase in the supply of mortgage liquidity may trigger speculative pressures on the housing market.

C. Effects of Entry and Changes in Market Structure

We further refine our analysis by assessing the impact on denial rates of credit expansion by new entrants (rather than incumbent institutions). In Table 8 we report the

results of our analysis of the effects of entry by new players on incumbent lending standards. Consistent with asymmetric information theories of competition in credit markets implying that an increase in the number of competing institutions increases adverse selection (e.g., Broeker, 1990, and Riordan, 1993), we find that an increase in the number of entrants (i.e., competing institutions) increases the denial rates of incumbent institutions in the overall mortgage market (column 1). In this regression, we use the market share of entrants, computed as the sum of each entrant's share in total loan applications, rather than the simple number of entrants, to control for the size of each entrant and capture overall market power of entrants. The evolution of denial rates in the subprime mortgage market, however, supports the notion of incumbents cutting their lending standards in reaction to the entry of new (and large) competitors (column 3). As the industry expanded and more subprime lenders entered specific metropolitan areas, denial rates by incumbent lenders went down. We take this as direct evidence of a reduction in lending standards in this market. We find a similar, though much less pronounced, effect in the prime market (column 2).

Denial rates of incumbent institutions are unlikely to affect the entry of new lenders to the extent that they reflect underlying applicant fundamentals. Then, by focusing on the effect of new entrants on the denial rates of incumbent lenders we are able to assess the independent effect of market entry (and expansion) on incumbent lending standards. That said, high denial rates could conceivably attract entry if they reflect collusion among incumbent lenders rather than the underlying fundamentals in the MSA. However, a close-to-zero correlation between the incumbent denial rate level (lagged) and our entry variable suggests that this is unlikely to be the case.

D. Alternative Proxies for Lending Standards

We now turn to the loan-to-income (LTI) ratio regressions (Table 9). As mentioned earlier, LTI ratios can be regarded as an alternative proxy for lending standards. We find that higher average LTI ratios are associated with lower unemployment rates and are more common in high income areas and where there is a larger percentage of the population that is self employed. Turning to our variables of interest, the results indicate that LTI ratios grow with the number of loan applications, particularly in the subprime market, confirming the notion of a boom effect on lending standards. The effect of competition is also confirmed with higher LTI ratios in MSAs with larger number of competing lenders. The house price appreciation variable enters only significantly in the subprime market regression, suggesting that LTI ratios in the prime market are not much affected by house price appreciation. In the subprime market, LTI ratios are strongly positively associated with house price appreciation.

E. Effects of Loan Sales

The increased ability of financial institutions to securitize mortgages over the past decade may have contributed to both the expansion of the mortgage market and the documented decline in lending standards. In Table 10, we explore how the increasing recourse to securitization of mortgages has affected denial rates in the prime and subprime mortgage industry. For each originated loan in the HMDA database, the variable "Purchaser type" denotes whether the loan was securitized (i.e., packaged with other loans and sold on the open market), kept on the books of the originating institution, or sold through a private sale to another financial institution). We use this information to compute the share of loans sold within a year of origination and use this as a proxy for the ability to securitize loans in a given MSA. Given the share of prime and subprime loans sold changes dramatically over the

period,[19] we allow this coefficient to be different for the 2000-2003 and the 2004-2006 periods.

The regression results indicate that in MSAs where a greater proportion of originated loans were sold within one year from origination, denial rates were lower. During the first part of the sample period, this effect was more pronounced for the prime market than the subprime market. However, during the second part of the sample period, when securitization of subprime loans increased dramatically, the effect turns more pronounced for the subprime mortgage market.

F. Effects on Overall Market Expansion and Delinquency Rates

After establishing a link between fast credit growth and easing lending standards in Table 9, Table 11 shows the contributions of the number of applications to overall credit market expansion, as measured by changes in the ratio of credit to income at the MSA level. We scale credit by income to control for changes in the level of income in the MSA. Notice that the contribution to credit market deepening of higher denial rates is much stronger in the subprime market compared to the prime market, indicating that the link between deteriorations in lending standards and credit expansion is stronger in the subprime market. This is not surprising given that the subprime mortgage market tends to concentrate on high-risk mortgages.

Securitization also appears to have favored the expansion of overall credit with a positive and significant effect on the credit-to-income ratios at the MSA level, particularly

---

[19] See Ashcraft and Schuermann (2007).

during the second part of the sample period. This evidence partially supports the view that disintermediation (through securitization) -provides lenders with incentives to extend riskier loans.

We complete our analysis with a formal establishment of the link between the rapid expansion of the subprime market and the current deterioration in delinquency rates. Table 12 presents evidence of the relation between delinquency rates and the credit growth demonstrated in our preliminary analysis. The share of seriously delinquent subprime loans, defined as subprime loans with 60 or more days delay in payment, increased more in the MSAs where subprime loan volume grew more. Splitting the change in loan volume into the change in number of loans and the mean loan amount reveals that both dimensions of changes in credit volumes had an impact on the delinquency rates. The rest of the variables, included to control for the changes in the general economic environment, come out with the expected signs. These results support the notion that current delinquency rates in the subprime mortgage market are related to the rapid expansion in this market that coincided with weakening lending standards.

VI. DISCUSSION AND CONCLUSIONS

This paper provides robust evidence that the recent rapid credit expansion in the subprime mortgage market was associated with easing credit standards and that the current troubles in this market are more severe in the areas where the expansion was faster. We link the change in lending standards to four main factors. First, we find evidence that standards declined more where the credit boom was larger. This lends support to the assertions that rapid credit growth episodes tend to breed lax lending behavior. Second, lower standards were associated

with a past fast rate of house price appreciation, consistent with the notion that lenders were to some extent gambling on a continuing housing boom, relying on the fact that borrowers in default could always liquidate the collateral and repay the loan. Third, change in market structure mattered: lending standards declined more in regions where (large and aggressive) previously absent institutions entered the market. Finally, there is evidence that disintermediation played a role, with standards declining more in regions where larger portions of the lenders' loan portfolios where sold to third players.

Our results are robust to a number of alternative specifications, including controlling for economic fundamentals using out-of-sample data, using alternative measures of lending standards, and introducing variables that capture the effect of new entrants on the denial rates of incumbent lenders. The latter approach allows us to assess the independent effect of market entry on incumbent lending standards and serves as an identification strategy for determining the effect of market expansion on lending standards. The results are also robust to using instrumental variables to identify the independent effect of the number of applications on loan denial rates. This mitigates concerns that our results are confounded by endogeneity between loan denial rates and the volume of loan applications. Finally, the effects we identify for the subprime market are either much weaker or absent in the prime mortgage market, lending additional support that the deterioration in lending standards was more pronounced in the subprime mortgage market. Our evidence suggests that while in the prime market lending standards were largely determined by underlying fundamentals (so that the probability of obtaining a loan relied on individual characteristics and regional and national economic conditions), for subprime loans, lending market conditions and strategic interactions played an important role in lending decisions.

Our results also shed some light on the effects of monetary policy on banks' lending standards. The evolution of U.S. interest rates mimics the evolution of denial rates in the prime market remarkably well, with denial rates increasing in 2005 following monetary tightening in 2004. However, we do not find such an effect of interest rates on denial rates for the subprime market, where denial rates remain relatively low. This suggests that monetary policy may have adversely affected lenders' risk-taking in the subprime mortgage market, with low interest rates affecting lending standards.

References

Asea, Patrick and Brock Blomberg, 1998, "Lending Cycles", *Journal of Econometrics* 83, 89-128.

Ashcraft, Adam, and Til Schuermann, 2007, "Understanding the Securitization of Subprime Mortgage Credit", mimeo, Federal Reserve Bank of New York.

Berger, Allen and Gregory Udell, 2004, "The institutional memory hypothesis and the procyclicality of bank lending behavior", *Journal of Financial Intermediation* 13, 458-495.

Bernanke, Ben, 2007, "Housing, Housing Finance, and Monetary Policy," Speech at the Federal Reserve Bank of Kansas City's Economic Symposium.

Bernanke, Ben and Mark Gertler, 1989, "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review* 79(1), 14-31.

Broecker , Thorsten, 1990, "Credit Worthiness Tests and Interbank Competition", *Econometrica* 58, 429-452.

Caruana, Jaime, 2002, "Asset Price Bubbles: Implications for Monetary, Regulatory, and International Policies," Speech at the Federal Reserve Bank of Chicago, April 24, Chicago.

Campbell, John Y. and Joao F. Cocco, 2003, "Household Risk Management and Optimal Mortgage Choice," *Quarterly Journal of Economics* 188(4), 1449-1494.

Case, Karl, and Robert Shiller, 2003, "Is There a Bubble in the Housing Market?" *Brooking Papers on Economic Activity* 2, 299-342.

Cutts, Amy Crews and Robert Van Order, 2005, "On the Economics of Subprime Lending," *Journal of Real Estate Finance and Economics* 30(2), 167-196.

Deng, Yongheng, John Quigley, and Robert Van Order, 2000,"Terminations, Heterogeneity and the Exercise of Mortgage Options," *Econometrica* 68(2), 275-308.

Dell'Ariccia, Giovanni and Robert Marquez, 2006, "Lending Booms and Lending Standards", *Journal of Finance* 61(5), 2511-2546.

Demyanyk, Yuliya, and Otto Van Hemert, 2007, "Understanding the Subprime Mortgage Crisis," Federal Reserve Bank of St. Louis, mimeo.

Ferguson, Roger, 2004, "The Role of Central Banks in Fostering Efficiency and Stability in the Global Financial System," Speech at the National Bank of Belgium Conference on Efficiency and Stability in an Evolving Financial System, May 17, Brussels.

FitchRatings, 2007, "The Impact of Poor Underwriting Practices and Fraud in Subprime Residential Mortgage-Backed Securities Performance," US Residential Mortgage Special Report, November 28, 2007.

Genesove, David, and Christopher Mayer, 1997, "Equity and Time to Sale in the Real Estate Market," *American Economic Review* 87, 255-269.

Gorton, Gary and Ping He, 2003, "Bank Credit Cycles", Unpublished manuscript, University of Pennsylvania.

Gourinchas, Pierre-Olivier, Rodrigo Valdes, and Oscar Landerretche, 2001, "Lending booms: Latin America and the World", *Economia,* 47-99.

Himmelberg, Charles, Christopher Mayer, and Todd Sinai, 2005, "Assessing High House Prices: Bubbles, Fundamentals, and Misperceptions," *Journal of Economic Perspectives* 19, 67-92.

Jimenez, Gabriel, and Jesus Saurina, 2006, "Credit Cycles, Credit Risk, and Prudential Regulation", *International Journal of Central Banking* 2(2), 65-98.

_____, Steven Ongena, José Luis Peydró, and Jesús Saurina, 2007, "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk?" Bank of Spain, unpublished manuscript

Kiyotaki, Nobihuro and John Moore, 1997, "Credit Cycles", *Journal of Political Economy* 105, 211-248.

Lown, Cara and Don Morgan, 2006, "The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey", *Journal of Money, Credit, and Banking* 38(6), 1575-97.

Matsuyama, Kiminori, 2007, "Credit Traps and Credit Cycles," *American Economic Review* 97, 503-516.

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

Pennington-Cross, Anthony, 2002, "Subprime Lending in the Primary and Secondary Markets," *Journal of Housing Research* 13, 31-50 .

Rajan, Raghuram, 1994, "Why Bank Credit Policies Fluctuate: A Theory and Some Evidence", *Quarterly Journal of Economics* 109, 399-441.

Reinhart, Carmen, and Kenneth Rogoff, 2008, "Is the 2007 U.S. Sub-prime Financial Crisis So Different? An International Historical Comparison", presented at the 2008 AEA meetings.

Riordan, Michael, 1993, "Competition and Bank Performance: A Theoretical Perspective," In: C. Mayer and X. Vives (Eds.), *Capital Markets and Financial Intermediation*. Cambridge: Cambridge University Press.

Ruckes, Martin, 2004, "Bank Competition and Credit Standards", *Review of Financial Studies* 17, 1073-1102.

Von Furstenberg, George M., and R. Jeffery Green, 1974, "Home Mortgage Delinquencies: A Cohort Analysis", *Journal of Finance* 29 (5), 1545-1548.

	Table 1. Coverage in HMDA		
	Total volume of originations (trillions of dollars)		
Year	HMDA database	Whole market	Coverage (percent)
2000	0.922	1.184	77.84
2001	1.854	2.080	89.14
2002	2.558	2.878	88.88
2003	3.338	3.810	87.60
2004	2.569	2.771	92.73
2005	2.888	3.031	95.28
2006	2.616	2.731	95.78

Table 2. Definitions and Sources of Variables

Name	Short name	Definition	Source
Loan application level			
Denied	D	Dummy variable taking value of 1 if the loan application is denied and 0 otherwise	HMDA
Subprime	S	Dummy variable taking value of 1 if the lender is in the HUD subprime lender list and 0 otherwise	HMDA
Loan amount	AMT	Principal amount of the loan or application (in thousands of dollars)	HMDA
Applicant income	INC	Total gross annual income the lender relied upon in making the credit decision (in thousands of dollars)	HMDA
Loan-to-income ratio	LIR	Ratio of loan amount to applicant income	HMDA
Poverty	POV	Dummy variable taking value of 1 if the applicant income is below the poverty line for a family of four published by the Department of Health and Human Services and 0 otherwise	HMDA
Refinancing	REFIN	Dummy variable taking value of 1 if the loan purpose is refinancing an existing loan and 0 otherwise (i.e., if the loan purpose is new home purchase)	HMDA
Owner-occupied	OCC	Dummy variable taking value of 1 if the property is intended for owner occupancy and 0 otherwise	HMDA
Female	F	Dummy variable taking value of 1 if the applicant is female and 0 otherwise	HMDA
Black	B	Dummy variable taking value of 1 if the applicant is black and 0 otherwise (i.e., if the applicant is white or hispanic)	HMDA
White	W	Dummy variable taking value of 1 if the applicant is white and 0 otherwise (i.e., if the applicant is black or hispanic)	HMDA
MSA level			
Denial rate	DR	Number of denied loan applications divided by the total number of applications	HMDA
House price appreciation	HPAPP	Change in the house price index	OFHEO
Average income	AVGINC	Total MSA income divided by population	BEA
Income growth	INCGROW	Change in total MSA income	BEA
Unemployment rate	UNEMP	Number of unemployed as a percent of labor force	BLS
Self employment rate	SELFEMP	Number of self-employed (those whose primary source of income is profits from their unincorporated businesses) divided by the number of employed	BEA
Log population	POP	Population in MSA (in log)	Census Bureau
Log number of competitors	COMP	Number of institutions accepting applications and extending loans in the MSA	HMDA
Log number of applications	APPL	Number of loan applications in the MSA	HMDA
Loan-to-income ratio	LIR	Average loan-to-income ratio on the loans originated in the MSA	HMDA
Credit-to-income ratio	CRGDP	Volume of originated loans divided by total MSA income	HMDA
Proportion of loans sold	SEC	Securitized loans as a percent of total originated loans	HMDA
Subprime delinquency rate	DEL	Subprime mortgages with 60 or more days of payment delay	LoanPerformance

Table 3. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Loan application level					
Denied	72,119,135	0.19	0.39	0	1
Subprime	72,119,135	0.23	0.42	0	1
Loan amount (in thousands of dollars)	72,119,135	160.59	125.41	1	1800
Applicant income (in thousands of dollars)	72,119,135	82.16	50.32	16	363
Loan-to-income ratio	72,119,135	4.25	0.56	3	6
Poverty	72,119,135	0.00	0.02	0	1
Refinancing	72,119,135	0.60	0.49	0	1
Owner-occupied	72,119,135	0.92	0.28	0	1
Female	72,119,135	0.29	0.45	0	1
Black	72,119,135	0.10	0.29	0	1
White	72,119,135	0.73	0.45	0	1
MSA level					
Denial rate	2,709	0.25	0.07	0.07	0.55
Denial rate of prime lenders	2,709	0.18	0.07	0.04	0.52
Denial rate of subprime lenders	2,703	0.50	0.08	0.00	0.73
House price appreciation	2,651	0.07	0.06	-0.05	0.41
Average income (in thousands of dollars)	2,653	29.72	6.22	13.57	71.90
Income growth	2,653	0.05	0.03	-0.34	0.48
Unemployment rate (in %)	2,709	5.28	2.06	1.90	17.40
Self employment rate	2,653	0.17	0.03	0.07	0.31
Log population	2,653	12.77	1.23	10.87	16.75
Log number of competitors	2,709	5.42	0.50	1.95	6.62
Log number of applications	2,709	9.31	1.24	6.13	13.38
Loan-to-income ratio	2,709	1.88	0.37	1.05	3.40
Credit-to-income ratio	2,653	0.12	0.08	0.00	0.58
Proportion of loans sold	2,709	0.46	0.10	0.00	0.78
Subprime delinquency rate (in %)	1,137	10.49	3.58	1.70	35.80
Denial rate of incumbents	2,316	0.25	0.07	0.07	0.52
Denial rate of prime lender incumbents	2,316	0.17	0.06	0.04	0.45
Denial rate of subprime lender incumbents	2,300	0.51	0.09	0.00	0.77
Denial rate of top-20 subprime lender incumbents	2,305	0.51	0.09	0.00	0.77
Denial rate of entrants	2,311	0.25	0.12	0.00	0.73
Denial rate of prime lender entrants	2,310	0.18	0.09	0.00	0.73
Denial rate of subprime lender entrants	2,299	0.47	0.17	0.00	1.00
Market share of entrants	2,316	0.05	0.05	0.00	0.98
Market share of prime lender entrants	2,316	0.05	0.06	0.00	0.99
Market share of subprime lender entrants	2,311	0.08	0.12	0.00	1.00

Table 4. Evolution of Denial Rates

Dependent variable: Denial rate	All lenders (1)	Prime lenders (2)	Subprime lenders (3)
House price appreciation	-0.234***	-0.150***	-0.308***
	[0.014]	[0.016]	[0.025]
Average income	-0.002***	-0.003***	-0.004**
	[0.001]	[0.001]	[0.001]
Income growth	0.003	-0.021	0.1
	[0.037]	[0.031]	[0.087]
Unemployment rate	0.003**	0.002	0.003*
	[0.001]	[0.001]	[0.002]
Self employment rate	0.046	0.08	-0.311**
	[0.075]	[0.083]	[0.130]
Log population	-0.180***	-0.232***	-0.353***
	[0.038]	[0.037]	[0.074]
Log number of competitors	0.018***	-0.003	-0.069***
	[0.006]	[0.008]	[0.012]
Log number of applications	-0.017***	0.025***	-0.030***
	[0.005]	[0.006]	[0.008]
Year = 2001	-0.052***	-0.086***	0.116***
	[0.004]	[0.004]	[0.006]
Year = 2002	-0.075***	-0.112***	0.067***
	[0.005]	[0.006]	[0.008]
Year = 2003	-0.070***	-0.135***	0.118***
	[0.007]	[0.008]	[0.010]
Year = 2004	0.001	-0.085***	0.099***
	[0.006]	[0.007]	[0.009]
Year = 2005	0.021***	-0.029***	0.098***
	[0.007]	[0.008]	[0.011]
Year = 2006	0.021***	-0.007	0.114***
	[0.008]	[0.009]	[0.012]
Constant	2.697***	3.065***	5.749***
	[0.470]	[0.465]	[0.913]
Observations	2651	2651	2646
Number of MSAs	379	379	379
R-squared	0.69	0.71	0.44

Notes: Dependent variable in regression (1) is the MSA-level weighted-average denial rate of all mortgage lenders, weighted by the size of each institution in terms of number of loan applications received. Dependent variable in regression (2) is the weighted-average denial rate of prime mortgage lenders. Dependent variable in regression (3) is the weighted-average denial rate of subprime mortgage lenders. For detailed definitions of the independent variables, see Table 2. All regressions are OLS and include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 5. Determinants of Denial Decision

Dependent variable: Dummy = 1 if application is denied	All lenders (1)	Prime lenders (2)	Subprime lenders (3)
Applicant income	0.454***	0.387***	0.995
	[0.051]	[0.056]	[0.058]
Loan-to-income ratio	0.922	0.813***	1.236***
	[0.051]	[0.049]	[0.068]
Poverty	1.057	1.206***	0.948
	[0.060]	[0.070]	[0.067]
Refinancing	1.573**	1.213	1.514**
	[0.284]	[0.213]	[0.274]
Owner-occupied	1.089	1.074	0.986
	[0.102]	[0.124]	[0.118]
Female	1.023	1.060***	0.897**
	[0.021]	[0.018]	[0.040]
Black	1.522***	1.526***	1.246***
	[0.079]	[0.085]	[0.050]
White	0.704***	0.674***	0.953
	[0.033]	[0.037]	[0.048]
Observations	5406178	4499811	906367
Number of lenders	7226	7041	185
Pseudo R-squared	0.07	0.07	0.02

Notes: Logit regressions using loan application-level data in 2000, where dependent variable is 1 if the loan application is denied and 0 if it is approved. The reported coefficients are odds ratios; hence a coefficient greater than 1 indicates that the application is more likely to be denied for higher values of the independent variable. All regressions include lender fixed effects (not reported). Robust standard errors clustered by lender are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 6. Prediction Errors

Dependent variable: Prediction error	All lenders	Prime lenders	Subprime lenders
	(1)	(2)	(3)
House price appreciation	-0.178***	-0.104***	-0.281***
	[0.012]	[0.013]	[0.028]
Average income	-0.004***	-0.005***	-0.003
	[0.001]	[0.001]	[0.002]
Income growth	-0.015	0.007	-0.002
	[0.029]	[0.026]	[0.077]
Unemployment rate	-0.001	-0.004***	0.003
	[0.001]	[0.001]	[0.002]
Self employment rate	-0.120*	-0.048	-0.414***
	[0.062]	[0.062]	[0.140]
Log population	-0.183***	-0.166***	-0.335***
	[0.032]	[0.030]	[0.084]
Log number of competitors	0.021***	0.008	-0.051***
	[0.006]	[0.007]	[0.016]
Log number of applications	-0.019***	-0.002	-0.026**
	[0.004]	[0.004]	[0.010]
Year = 2001	-0.151***	-0.139***	-0.043***
	[0.005]	[0.005]	[0.011]
Year = 2002	-0.166***	-0.142***	-0.131***
	[0.004]	[0.004]	[0.009]
Year = 2003	-0.124***	-0.130***	-0.012
	[0.004]	[0.004]	[0.009]
Year = 2004	-0.046***	-0.084***	-0.020***
	[0.003]	[0.003]	[0.007]
Year = 2005	-0.015***	-0.022***	-0.031***
	[0.003]	[0.003]	[0.006]
Year = 2006	0	0	0
	[0.000]	[0.000]	[0.000]
Constant	2.660***	2.355***	5.026***
	[0.402]	[0.379]	[1.045]
Observations	2273	2273	2268
Number of MSAs	379	379	379
R-squared	0.90	0.87	0.42

Notes: Dependent variable, prediction error, is calculated as the MSA-level average of the actual denial rate minus the MSA-level average of the denial rate predicted based on the logit regressions in Table 5. In each year, the coefficients obtained on the 2000 data are used to predict the probability of denial for a loan application. The average of these predicted values is the predicted denial rate. For detailed definitions of the independent variables, see Table 2. All regressions are OLS and include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 7. Endogeneity

Dependent variable: Denial rate	Log number of subprime loan applications (1)	IV estimation using log number of prime loan applications (2)	Lagged house price appreciation (3)
House price appreciation	-0.329***	-0.334***	
	[0.025]	[0.026]	
House price appreciation, lagged			-0.226***
			[0.042]
Average income	-0.004**	-0.003*	0.002
	[0.001]	[0.001]	[0.002]
Income growth	0.108	0.051	-0.103
	[0.090]	[0.050]	[0.086]
Unemployment rate	0.003*	0.003	0.005**
	[0.002]	[0.002]	[0.002]
Self employment rate	-0.271**	-0.263**	-0.167
	[0.131]	[0.125]	[0.133]
Log population	-0.385***	-0.266***	-0.313***
	[0.073]	[0.062]	[0.089]
Log number of competitors	-0.074***	-0.035**	-0.055***
	[0.013]	[0.017]	[0.013]
Log number of all applications			-0.033***
			[0.010]
Log number of subprime applications	-0.013**	-0.074***	
	[0.006]	[0.019]	
Year = 2001	0.104***	0.096***	0.019*
	[0.006]	[0.005]	[0.010]
Year = 2002	0.053***	0.051***	-0.035***
	[0.008]	[0.006]	[0.009]
Year = 2003	0.104***	0.150***	0.01
	[0.009]	[0.016]	[0.009]
Year = 2004	0.100***	0.166***	-0.023***
	[0.011]	[0.022]	[0.006]
Year = 2005	0.095***	0.148***	-0.033***
	[0.012]	[0.019]	[0.005]
Year = 2006	0.110***	0.142***	0
	[0.012]	[0.015]	[0.000]
Constant	5.996***	4.679***	5.094***
	[0.910]	[0.747]	[1.132]
Excluded instruments		Log number of prime loan applications	
F-test of excluded instruments (p-value)		0.000***	
Observations	2646	2646	2267
Number of MSAs	379	379	379
R-squared	0.43	0.40	0.40

Notes: Dependent variable in all regressions is the MSA-level weighted-average denial rate of subprime mortgage lenders, weighted by the size of each institution in terms of number of loan applications received. In regression (1), log number of applications is replaced with the log number of subprime applications. In regression (2), log number of prime applications is used as an instrument for log number of subprime applications. In regression (3), house price appreciation is replaced with its lagged value. For detailed definitions of other independent variables, see Table 2. Regressions (1) and (3) are estimated using OLS and regression (2) is estimated using instrumental variables. All regressions include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. We also report the p-value of the F-test of excluded instruments. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 8. Market Entry and Denial Rates of Incumbents in Prime and Subprime Markets

	All entrants (1)	Prime entrants (2)	Subprime entrants (3)
House price appreciation	-0.205***	-0.096***	-0.297***
	[0.013]	[0.013]	[0.027]
Average income	-0.004***	-0.007***	-0.001
	[0.001]	[0.001]	[0.002]
Income growth	0.009	0.041	0.031
	[0.042]	[0.036]	[0.094]
Unemployment rate	0.001	-0.001	0.006**
	[0.001]	[0.001]	[0.002]
Self employment rate	-0.087	-0.074	-0.291**
	[0.074]	[0.070]	[0.136]
Log population	-0.164***	-0.224***	-0.348***
	[0.042]	[0.038]	[0.093]
Log number of competitors	0.006	0.011**	-0.063***
	[0.006]	[0.004]	[0.014]
Log number of applications	-0.052***	-0.031***	-0.022**
	[0.005]	[0.004]	[0.010]
Market share of entrants	0.024		
	[0.028]		
Market share of entrants into prime market		-0.023*	
		[0.014]	
Market share of entrants into subprime market			-0.149***
			[0.032]
Year=2001	-0.104***	-0.104***	0.033***
	[0.005]	[0.005]	[0.012]
Year=2002	-0.110***	-0.120***	-0.026***
	[0.005]	[0.005]	[0.009]
Year=2003	-0.085***	-0.117***	0.022**
	[0.005]	[0.005]	[0.010]
Year=2004	-0.021***	-0.082***	0.001
	[0.003]	[0.004]	[0.007]
Year=2005	0.003	-0.019***	-0.013**
	[0.003]	[0.003]	[0.005]
Year=2006	0	0	0
	[0.000]	[0.000]	[0.000]
Constant	2.990***	3.568***	5.572***
	[0.527]	[0.476]	[1.153]
Observations	2273	2273	2263
Number of MSAs	379	379	379
R-squared	0.76	0.74	0.34

Notes: Dependent variable in regression (1) is the MSA-level weighted-average denial rate of incumbent mortgage lenders, weighted by the size of each institution in terms of number of loan applications received. Dependent variable in regression (2) is the weighted-average denial rate of incumbent prime mortgage lenders. Dependent variable in regression (3) is the weighted-average denial rate of incumbent subprime mortgage lenders. Incumbent institutions are those that were active in the MSA at the start of the year. Entrants are those that entered the MSA during a given year. We consider each year that an institution entered the MSA an actual entry, even if the institution had entered and then exited the MSA. Market share of entrants is the market share in loan applications received by entrants. Market share of entrants into prime market is loan applications received by entering prime mortgage lenders as a fraction of loan applications received by all subprime mortgage lenders. Market share of entrants into subprime market is loan applications received by entering subprime mortgage lenders as a fraction of loan applications received by all subprime mortgage lenders. All regressions include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 9. Lending Standards

Dependent variable: Loan-to-income ratio	All lenders (1)	Prime lenders (2)	Subprime lenders (3)
House price appreciation	0.105	0.103	0.222***
	[0.070]	[0.072]	[0.079]
Average income	0.037***	0.038***	0.029***
	[0.003]	[0.003]	[0.004]
Income growth	-0.886***	-0.871***	-0.924***
	[0.159]	[0.167]	[0.145]
Unemployment rate	-0.018***	-0.020***	-0.009*
	[0.004]	[0.004]	[0.005]
Self employment rate	1.559***	1.523***	1.578***
	[0.298]	[0.303]	[0.383]
Log population	0.255*	0.315**	-0.176
	[0.143]	[0.147]	[0.168]
Log number of competitors	0.120***	0.123***	0.277***
	[0.034]	[0.035]	[0.034]
Log number of applications	0.109***	0.090***	0.265***
	[0.017]	[0.017]	[0.021]
Year = 2001	-0.014	-0.005	-0.029**
	[0.011]	[0.011]	[0.014]
Year = 2002	0.005	0.013	0.002
	[0.014]	[0.014]	[0.018]
Year = 2003	-0.028	-0.021	-0.050**
	[0.018]	[0.018]	[0.025]
Year = 2004	0.085***	0.084***	0.03
	[0.018]	[0.019]	[0.024]
Year = 2005	0.016	0.029	-0.108***
	[0.022]	[0.023]	[0.028]
Year = 2006	-0.060**	-0.062**	-0.085***
	[0.024]	[0.025]	[0.031]
Constant	-4.301**	-4.915***	-0.801
	[1.769]	[1.822]	[2.089]
Observations	2651	2651	2646
Number of MSAs	379	379	379
R-squared	0.67	0.65	0.6

Notes: Dependent variable in regression (1) is the MSA-level average loan-to-income ratio of all originated loans. Dependent variable in regression (2) is the average loan-to-income ratio of loans originated by prime mortgage lenders. Dependent variable in regression (3) is the average loan-to-income ratio of loans originated by subprime mortgage lenders. For detailed definitions of the independent variables, see Table 2. All regressions are OLS and include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 10. Securitization and Lending Standards

Dependent variable: Denial rate	All lenders (1)	Prime lenders (2)	Subprime lenders (3)
House price appreciation	-0.193***	-0.122***	-0.269***
	[0.014]	[0.015]	[0.026]
Average income	-0.002**	-0.004***	-0.002
	[0.001]	[0.001]	[0.001]
Income growth	0.043	0.025	0.096
	[0.040]	[0.033]	[0.083]
Unemployment rate	0.003**	0.001	0.004*
	[0.001]	[0.001]	[0.002]
Self employment rate	0.092	0.112	-0.271**
	[0.070]	[0.079]	[0.130]
Log population	-0.199***	-0.296***	-0.256***
	[0.042]	[0.041]	[0.078]
Log number of competitors	0.035***	0.009	-0.057***
	[0.007]	[0.008]	[0.012]
Log number of applications	-0.010*	0.034***	-0.032***
	[0.005]	[0.006]	[0.009]
Proportion of loans sold	-0.256***	-0.226***	-0.123***
	[0.019]	[0.020]	[0.030]
Proportion of loans sold * Year >= 2004	0.024	0.076***	-0.110***
	[0.015]	[0.017]	[0.026]
Year = 2001	-0.027***	-0.063***	0.126***
	[0.004]	[0.004]	[0.007]
Year = 2002	-0.040***	-0.079***	0.080***
	[0.005]	[0.005]	[0.009]
Year = 2003	-0.040***	-0.106***	0.129***
	[0.007]	[0.007]	[0.011]
Year = 2004	0.003	-0.104***	0.146***
	[0.008]	[0.010]	[0.013]
Year = 2005	0.019**	-0.050***	0.138***
	[0.008]	[0.010]	[0.013]
Year = 2006	0.016*	-0.028***	0.146***
	[0.008]	[0.010]	[0.013]
Constant	2.864***	3.838***	4.444***
	[0.521]	[0.508]	[0.972]
Observations	2651	2651	2646
Number of MSAs	379	379	379
R-squared	0.73	0.74	0.45

Notes: Dependent variable in regression (1) is the MSA-level average loan-to-income ratio of all originated loans. Dependent variable in regression (2) is the average loan-to-income ratio of loans originated by prime mortgage lenders. Dependent variable in regression (3) is the average loan-to-income ratio of loans originated by subprime mortgage lenders. Proportion of loans sold, the securitization measure, is the ratio of the number of loans sold within a year of origination to the total number of loans approved in the MSA. A variable constructed as the interaction of proportion of loans sold and a dummy variable that is 1 for years 2004, 2005, and 2006 is also included. For detailed definitions of the other independent variables, see Table 2. All regressions are OLS and include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 11. Securitization and Mortgage Market Expansion

Dependent variable: Credit-to-income ratio	All lenders	Prime lenders	Subprime lenders
	(1)	(2)	(3)
House price appreciation	0.005	0.003	0.009*
	[0.019]	[0.016]	[0.005]
Average income	-0.003***	-0.002**	-0.001***
	[0.001]	[0.001]	[0.000]
Income growth	-0.085*	-0.079*	-0.003
	[0.047]	[0.042]	[0.007]
Unemployment rate	0.001	0	0.001***
	[0.001]	[0.001]	[0.000]
Self employment rate	-0.161**	-0.141**	-0.037**
	[0.072]	[0.064]	[0.017]
Log population	0.191***	0.142***	0.045***
	[0.050]	[0.044]	[0.009]
Log number of competitors	0.012**	0.005	0.017***
	[0.005]	[0.004]	[0.002]
Log number of applications	0.121***	0.110***	0.011***
	[0.005]	[0.004]	[0.001]
Denial rate	-0.127***	-0.030*	-0.036***
	[0.020]	[0.017]	[0.003]
Proportion of loans sold	0.103***	0.129***	0.002
	[0.015]	[0.012]	[0.003]
Proportion of loans sold * Year >= 2004	0.023	-0.015	0.026***
	[0.015]	[0.013]	[0.003]
Year = 2001	-0.018***	-0.011***	-0.001
	[0.003]	[0.003]	[0.001]
Year = 2002	-0.021***	-0.012***	-0.004***
	[0.004]	[0.004]	[0.001]
Year = 2003	-0.017***	-0.010**	-0.003***
	[0.005]	[0.005]	[0.001]
Year = 2004	-0.034***	-0.025***	-0.005***
	[0.006]	[0.006]	[0.001]
Year = 2005	-0.025***	-0.017***	-0.005***
	[0.006]	[0.006]	[0.001]
Year = 2006	-0.029***	-0.017***	-0.008***
	[0.006]	[0.006]	[0.001]
Constant	-3.408***	-2.717***	-0.715***
	[0.626]	[0.549]	[0.112]
Observations	2651	2651	2646
Number of MSAs	379	379	379
R-squared	0.78	0.79	0.66

Notes: Dependent variable in regression (1) is the ratio of total originated loans to total income at the MSA level. Dependent variable in regression (2) is the ratio of loans originated by prime mortgage lenders to total income. Dependent variable in regression (3) is the ratio of loans originated by subprime mortgage lenders to total income. Proportion of loans sold, the securitization measure, is the ratio of the number of loans sold within a year of origination to the total number of loans approved in the MSA. A variable constructed as the interaction of proportion of loans sold and a dummy variable that is 1 for years 2004, 2005, and 2006 is also included. Denial rate is market-specific, i.e., it is the denial rate for prime mortgage lenders in regression (2) and that for subprime mortgage lenders in regression (3). For detailed definitions of the other independent variables, see Table 2. All regressions are OLS and include MSA fixed effects (not reported) and year fixed effects. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 12. Delinquency Rates: Boom Gone Bad?

Dependent variable: Change in subprime delinquency rate	(1)	(2)
Change in subprime loan volume	1.969***	
	[0.294]	
Change in number of subprime loan originations		1.754***
		[0.312]
Change in average subprime loan amount		4.253***
		[0.788]
House price appreciation, lagged	-3.797**	-3.978**
	[1.847]	[1.841]
Average loan-to-income ratio, lagged	2.506***	2.211***
	[0.451]	[0.462]
Log number of subprime competitors, lagged	1.524***	1.728***
	[0.403]	[0.408]
Change in unemployment rate	1.456***	1.417***
	[0.296]	[0.302]
Change in income	-0.711***	-0.720***
	[0.206]	[0.204]
Constant	-9.684***	-10.553***
	[1.528]	[1.562]
Observations	374	374
R-squared	0.54	0.54

Notes: Dependent variable in both regressions is the change in subprime delinquency rate from 2004 to 2006. Change in subprime loan volume is calculated as the difference between the total volume of loans originated by subprime mortgage lenders in 2000 and 2004. Change in subprime loan originations is calculated as the difference between the number of loans originated by subprime mortgage lenders in 2000 and 2004. Change in subprime loan amount is calculated as the difference between the average loan amount for loans originated by subprime mortgage lenders in 2000 and 2004. Average loan-to-income ratio is calculated for the loans originated by subprime mortgage lenders. For detailed definitions of the other independent variables, see Table 2. Both regressions are cross-section OLS. Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

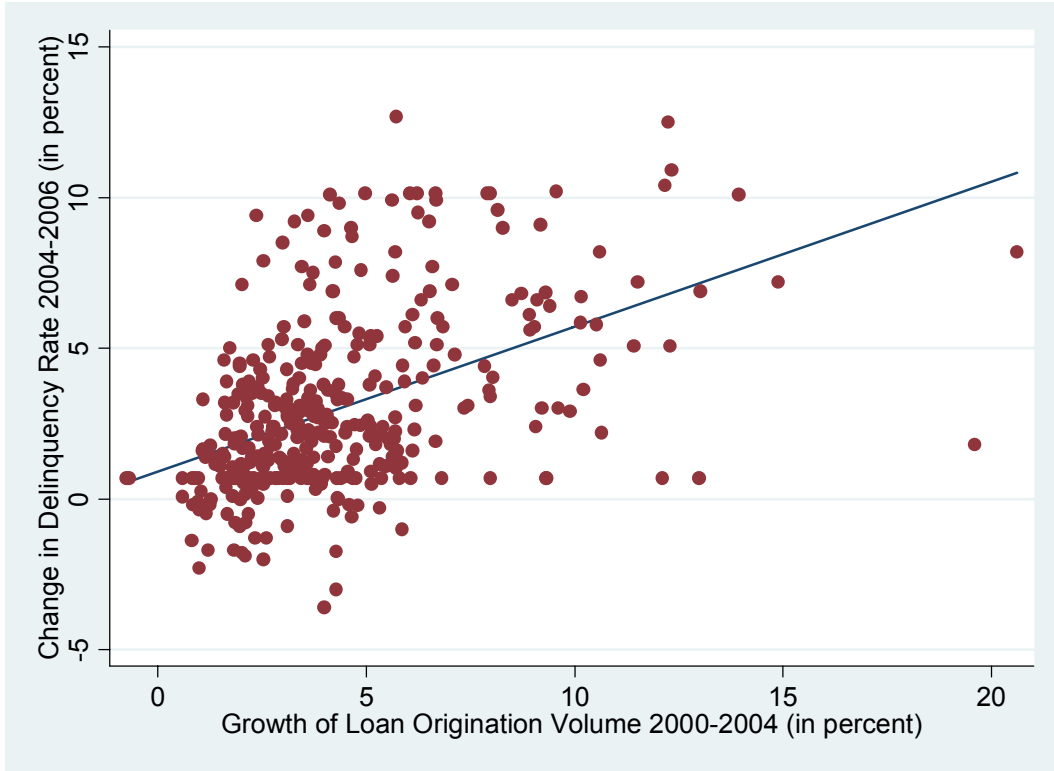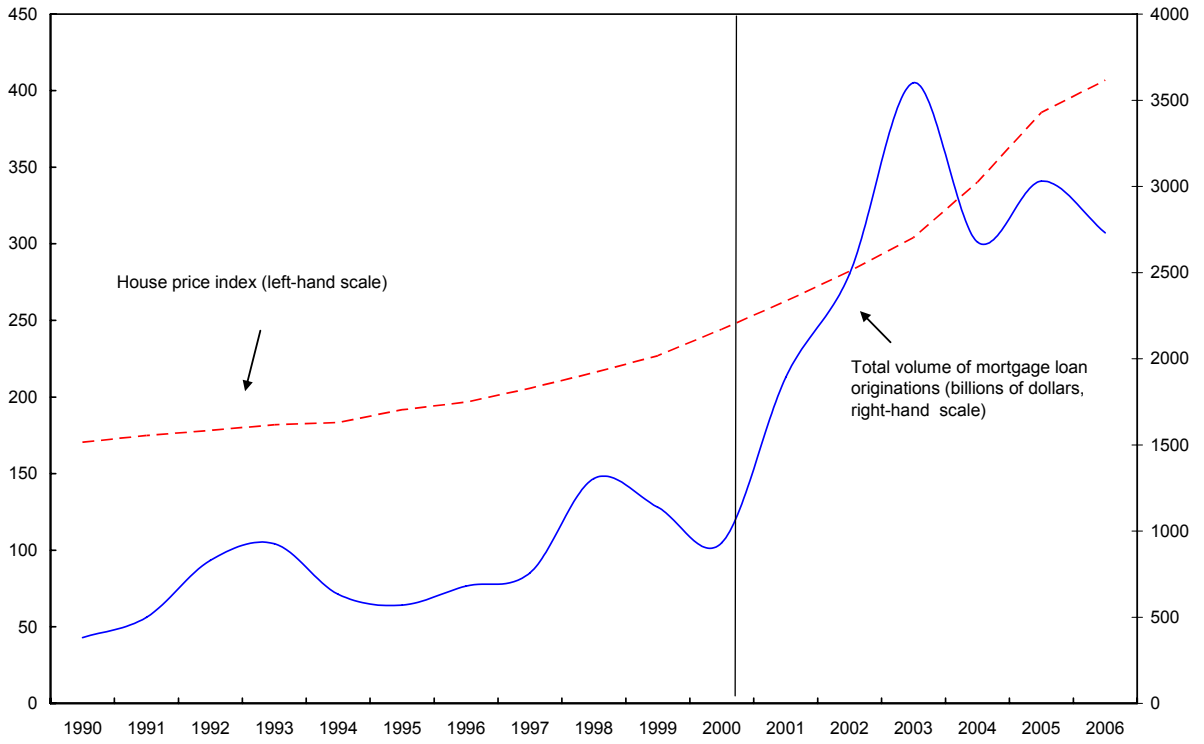Figure 1. A Credit Boom Gone Bad?

Figure 2. House Prices and Credit Boom

Figure 3. Lending Standards and Subprime Credit Boom