CREDIT BOOMS AND LENDING STANDARDS:

EVIDENCE FROM THE SUBPRIME MORTGAGE MARKET

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

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Abstract

This paper links the current subprime mortgage crisis to a decline in lending standards associated with the rapid expansion of this market. We show that lending standards declined more in areas that experienced larger credit booms and house price increases. We also find that the underlying market structure mattered, with entry of new, large lenders triggering declines in lending standards. Finally, lending standards declined more 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 light on the relationship between credit booms and financial instability.

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* The authors are all at the IMF Research Department (Financial Studies Division). Dell'Ariccia and Laeven are also at the CEPR. We would like to thank Richard Baldwin, Tam Bayoumi, Stijn Claessens, Enrica Detragiache, Gianni De Nicolo, David Gussmann, Robert Hauswald, Patrick Honohan, Simon Johnson, Pete Kyle, Robert Marquez, Rebecca McCaughrin, Donald Morgan, Marcelo Pinheiro, Calvin Schnure, and seminar participants at the International Monetary Fund, Fannie Mae, George Washington University, American University, the Federal Reserve Bank of New York, and the University of Kansas for helpful discussions and/or comments on an earlier version of this paper. We would also like to thank Chris Crowe for sharing his data. Mattia Landoni provided outstanding research assistance. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF, its Executive Board, or its Management. Address for correspondence: Giovanni Dell'Ariccia, IMF, 700 19th Street NW, Washington, DC 20431 USA. E-mail: Gdellariccia@imf.org.

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 rapidly, evolving from a small niche segment to a major portion of the U.S. mortgage market. Anecdotal evidence suggests that this trend was accompanied by a decline in credit standards and excessive risk taking by lenders, and possibly by 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 link empirically lending standards and delinquency rates in the subprime mortgage market to its 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). We find evidence that this relationship is linked to a decrease in lending 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.

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

Consistent with recent theories suggesting that banks behave more aggressively during booms than in tranquil times, the size of the boom mattered. Denial rates declined more and loan-to-income ratios rose more where the number of loan applications rose faster.

The subprime boom also shared other characteristics often associated with aggregate boom-bust credit cycles, such as financial innovation (in the form of securitization), changes in market structure, fast rising house prices, and ample aggregate liquidity.[2] 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 deteriorating more in areas where lenders sold a larger proportion of originated loans. Lending standards also declined more in areas with more pronounced housing booms. Finally, easy monetary conditions also played an amplifying role. These effects were more pronounced in the subprime mortgage market than in the prime mortgage market, where loan denial decisions were 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 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

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

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 twofold. First, the paper sheds some light on the origins of the current crisis by establishing a link between credit expansion and lending standards in the subprime mortgage market, and by identifying increased loan sales and changes in the structure of local credit markets as factors amplifying the decline in denial rates and the increase in loan-to-income ratios.

Second, the boom-bust cycle of the subprime mortgage industry, beyond being of interest in itself, provides an excellent "lab case" to gain insights into the black box of credit booms in less developed credit markets. Subprime borrowers are generally riskier, more heterogeneous, can post less collateral, and have shorter or worse credit histories (if any) than their prime counterparts. These are all features often prevalent in developing countries. At the same time, the wealth of information available and the geographical variation (Figure 2) in this market allow 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. Thus, the subprime mortgage market provides an almost ideal testing ground for theories of intermediation based on asymmetric information (and adverse selection in particular).

From a policy point of view, the evidence in this paper alerts against the dangers arising from lax standards during credit booms, and it is relevant for the debate on cyclical management of prudential regulation and on the potential effects of monetary policy on banks' risk-taking (Jimenez et al., 2007). To the extent that during booms standards decline

more than justified by economic fundamentals, our findings are consistent with the view that bankers have "an unfortunate tendency" to lend too aggressively at the peak of a cycle and that most bad loans results from this aggressive type of lending.[3] That said, credit booms may still be beneficial. While, in light of the recent financial turmoil, it is easy to argue that standards were excessively lax, it is much harder to compute the benefits associated with greater access to credit and, hence, the net welfare effect of the subprime expansion.

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.

II. RELATED LITERATURE

Several studies examine the interaction between economic fluctuations and changes in bank credit (Bernanke and Lown, 1991, Peek and Rosengren, 2000, Black and Strahan, 2002, and Calomiris and Mason, 2003). However, little evidence has been collected on how lending standards are related to credit booms. Asea and Blomberg (1998) find that loan collateralization increases during contractions and decreases during expansions, while Lown and Morgan (2003) show that lending standards are associated with innovations in credit. Jimenez, Salas, and Saurina (2006) find that during booms riskier borrowers obtain credit and collateral requirements decrease.

A few papers have examined the recent boom from a house-price perspective, while not strictly focusing on the subprime market (Himmelberg et al., 2005, and Case and Shiller,

[3] Former Federal Reserve Chairman Alan Greenspan in a speech delivered before the Independent Community Bankers of America on March 7, 2001. See also Bernanke (2007).

2003). The literature on subprime mortgages has instead largely focused on issues of credit access and discrimination and on what determines access to subprime versus prime lenders. Our loan level analysis builds on a model from Munnell et al. (1996) who show that race has played an important, although diminishing, role in the decision to grant a mortgage. A few papers examine how local risk factors affect the fraction of the market that uses subprime lending (Pennington-Cross, 2002). Other studies focus on how borrowers choose a mortgage and on their decision to prepay or default on a loan (Deng et al., 2000, Campbell and Cocco, 2003, and Cutts and Van Order, 2005).

A few recent papers focus on how securitization affects the supply of loans (Loutskina and Strahan, 2007) and mortgage delinquencies. Demyanyk and Van Hemert (2007) find that delinquency and foreclosure rates of subprime borrowers are to a large extent determined by high loan-to-value ratios. Mian and Sufi (2007) link the increase in delinquency rates to a disintermediation-driven increase in loan originations, while Keys et al. (2007) find that loans that are easier to securitize default more frequently.

Most theoretical explanations for variations in credit standards rely on financial accelerators based on the interaction of asymmetric information and business cycle factors (Bernanke and Gertler,1989, Kiyotaki and Moore, 1997, and Matsuyama, 2007; see Ruckes, 2004, for a review of this literature). Others focus on the potential for herding behavior by bank managers (Rajan, 1994), on banks' limited capacity in screening applications (Berger and Udell, 2004), or on how strategic interaction among asymmetrically informed banks may lead to changes in lending standards during booms (Gorton and He, 2003, and Dell'Ariccia and Marquez, 2006).

III. DATA AND DESCRIPTIVE STATISTICS

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 and subprime mortgage lenders we are also able to identify differences between the two lending markets. 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.[4] The HMDA data covers a broad 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

[4] The purpose of the Act was two-fold: enhance enforcement of anti-discriminatory lending laws and disseminate information to guide investments in housing.

lending in its portfolio.[5] 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 3). 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.

Since 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 can be used as an alternative indicator (to the HUD list) to classify subprime loans. For the years with available

[5] Any depository institution 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 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 incomplete. Yet, U.S. Census figures show that about 83 percent of the population lived in metropolitan areas over our sample period, and hence, the bulk of residential mortgage lending activity is likely to be reported under the HMDA.

data, the ranking of subprime lenders using the rate spread variable alone coincides closely with the ranking in the HUD list.[6] The HUD list of subprime lenders is also preferable to the rate spread information for a number of reasons. First, rate spreads are not available prior to 2004. Second, subprime loans do not necessarily have APRs that are three (or five) percentage points above a comparable Treasury rate but may reflect fees and yield spread premiums or other borrower characteristics determined by the lender. Third, and most importantly, the rate spread in HMDA is available only for originated loans, making it impossible to calculate denial rates for prime and subprime applications 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 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. We therefore eliminate applicants with missing applicant income or applicant income of exactly $10,000. 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 and refinancing loans as their risk profile is likely to differ from that of other loans. Finally, and importantly, we eliminate all application records that did not end in one of the following three 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-

[6] The correlation is around 0.8.

counting as these loans are reported both by the originating institution and the purchasing institution.

We supplement the HMDA information with MSA-level data on economic and social indicators published by federal agencies, 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 data company. Data on these delinquency rates are available only for 2004 onwards.

Over the last decade, subprime mortgage lending has expanded rapidly both in terms of 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 in 2006. Average loan amount also grew reaching $132,784 in 2006 or 90 percent of the prime mortgage average amount. In absolute terms, the subprime market reached a size of about $1.3 trillion in 2006.

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 4). 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.

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.[7] 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. As expected, the denial rate of subprime lenders is much higher (about 2.5 times) than the denial rate of prime lenders.

IV. EMPIRICAL METHODOLOGY

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.

[7] 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.

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:

$$DR_{it} = \alpha_t + \gamma_i + \beta_1 AVGINC_{it} + \beta_2 INCGROW_{it} + \beta_3 UNEMP_{it} + \beta_4 SELFEMP_{it} + \beta_5 POP_{it} + \beta_6 COMP_{it} + \beta_7 HPAPP_{it-1} + \beta_8 APPL_{it} + \varepsilon_{it}, \quad \text{(Eq. 1)}$$

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.[8] 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. 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

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

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.

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.[9] 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

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

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 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. 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 all variables they consider. Specifically, we do not have data on borrower credit scores. We augment their specification 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:

$$D_{jk} = \alpha_k + \gamma_1 INC_j + \gamma_2 LIR_j + \gamma_3 POV_j + \gamma_4 REFIN_j + \gamma_5 OCC_j + \gamma_6 F_j + \gamma_7 B_j + \gamma\beta_8 W_j + \varepsilon_{jk}, \quad \text{(Eq. 2)}$$

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 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).

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:

$$LIR_{it} = \alpha_t + \gamma_i + \beta_1 AVGINC_{it} + \beta_2 INCGROW_{it} + \beta_3 UNEMP_{it} + \beta_4 SELFEMP_{it} + \beta_5 POP_{it} + \beta_6 COMP_{it} + \beta_7 HPAPP_{it-1} + \beta_8 APPL_{it} + \varepsilon_{it}, \quad \text{(Eq. 3)}$$

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. Results for the denial rate regression, controlling for MSA fixed effects, are in Table 4. 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 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 number 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, 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. 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 2003 and then increased from 2004 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 mid-2004 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,[10] this did not happen for subprime mortgages. Indeed, a regression specification replacing the year fixed effects with the Federal Fund rate returned a positive coefficient for the prime market, but not for the subprime (not reported).[11]

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[10] 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).

[11] One explanation for this result relies on the fact that prime mortgages are mostly fixed-rate and are by definition underwritten for the fully-indexed cost while subprime mortgages are mostly adjustable-rate loans with low teaser rates. It is possible that lending standards in the subprime market were already flawed in the sense that the denial decision was based on initial debt-to-income ratios calculated using the teaser rate instead

(continued)

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) 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 (compared to a standard deviation of denial rates of about 7 percent in both markets).

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

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of considering payment shocks that would occur with the reset of the loan rate. In that case, denial rates would not respond to higher short-term interest rates, concealing the potential impact of monetary policy on lending standards.

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.[12] 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.

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

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, 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 and Robustness 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. For robustness, we also estimate our model using the number of originated loans and the total loan volume as alternative measures of market expansion, obtaining similar results (Table 7, columns 3 and 4).

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 (5) 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. Crowe (2008) finds that in MSAs with a larger portion of the population belonging to Evangelical churches house prices tend to rise disproportionately when the "Rapture Index" rises.[13] This index maps current events into a subjective probability of an imminent coming of a time of "extreme and terrible" events and as such is independent from denial rates at the MSA level. We can then use the interaction term of the share of Evangelicals in the MSA population and change in the Rapture index as an instrument for house price appreciation. The results of this exercise are reported in column (6) of Table 7 and confirm our original estimates.

C. Sensitivity Analysis: Time and Size Effects

So far we have imposed the coefficient linking lending standards to market expansion to be invariant across time and markets of different sizes. Yet, anecdotal evidence suggests that the relaxation of standards associated with housing boom frenzy was more prevalent in large metropolitan areas and that abundant liquidity due to loose monetary condition was at least in part to be blamed. In this section, we attempt to formally test those assumptions by explicitly allowing the "credit boom" coefficient to vary over time, with changes in monetary policy, and across markets of different sizes.

First, we consider how this relationship has evolved over our sample period by interacting the log number of applications with a simple linear trend (Table 8, column 1). The negative and significant sign of the coefficient of this interacted term suggests that the link between boom and standards become increasingly stronger over the sample period.

[13] The Rapture Index is available at http://www.raptureready.com/rap2.html

We test for the role of monetary policy by interacting the log number of applications with the Federal Fund rate. The positive and significant coefficient of this interacted term suggests that the effect of credit expansion on lending standards is indeed stronger when monetary policy is loose (Table 8, column 2). Notably, this effect survives when we control for a time trend (column 3).

Next, we confirm that the relationship between booms and standards was stronger in relatively larger markets in a specification interacting our boom variable with the log of the MSA population (Table 8, column 4). While the linear coefficient for the boom variable is positive and significant, the overall relationship is negative for essentially all markets and becomes significant for markets above the 25th percentile of the population distribution. The relationship between lending standards and credit expansion also appears to depend on the size of the boom itself. Table 9 shows that the coefficient of log number of applications is larger and more significant when our baseline specification is estimated on subsamples of MSAs with the number of application above the median and the growth rate of applications above the median.

D. 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 10 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 (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. The evidence in this section suggests that, as for small business lending (see Petersen and Rajan, 2002), information technology may have reduced but has not eliminated the importance of geography in the mortgage market

E. Alternative Proxies for Lending Standards

We now turn to the loan-to-income (LTI) ratio regressions (Table 11). 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.

F. 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 12, columns 1 to 3, 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 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 sold loans

changes dramatically over the period,[14] we allow this coefficient to be different for the 2000-2003 and the 2004-2006 periods.

The results indicate that denial rates were lower in MSAs where a greater proportion of originated loans were sold within one year from origination, consistent with findings by Mian and Sufi (2007) and Keys et al. (2007). During the first part of the sample period, this effect was more pronounced for the prime 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.

In the remainder of Table 12, we document the relationship between the number of applications and 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 credit-to-income ratios, particularly 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.

[14] See Ashcraft and Schuermann (2007).

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 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, we find 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 changes in local market structure on lending standards. The results are also robust to using instrumental variables to identify the independent effect of the number of applications and changes in house prices 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, 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. Although we do not find such a relationship for the subprime market, where denial rates remain relatively low, we find evidence suggesting that the negative impact of rapid credit growth on lending standards was more pronounced when interest rates were lower, suggesting that lax monetary policy may exacerbate the effects of booms on lending standards.

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Table 1. Coverage in HMDA

Year	Total volume of originations (trillions of dollars)		
	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	2.17	1.28	1	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

	All lenders	Prime lenders	Subprime lenders
Dependent variable: Prediction error	(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. Robustness

			Alternative measures of boom			
Dependent variable: Denial rate	Log number of subprime applications (1)	IV: log number of prime loan applications (2)	Originations (3)	Volume of originated loans (4)	Lagged house price appreciation (5)	IV: Evangelicals and Rapture index (6)
House price appreciation	-0.329***	-0.334***	-0.278***	-0.272***		-0.576***
	[0.025]	[0.026]	[0.026]	[0.025]		[0.167]
House price appreciation, lagged					-0.226***	
					[0.042]	
Average income	-0.004**	-0.003*	-0.003**	-0.002	0.002	-0.004***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]
Income growth	0.108	0.051	0.092**	0.068	-0.103	0.189***
	[0.090]	[0.050]	[0.045]	[0.045]	[0.086]	[0.071]
Unemployment rate	0.003*	0.003	0.003	0.002	0.005**	0
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.003]
Self employment rate	-0.271**	-0.263**	-0.332***	-0.310***	-0.167	-0.289**
	[0.131]	[0.125]	[0.120]	[0.120]	[0.133]	[0.124]
Log population	-0.385***	-0.266***	-0.300***	-0.272***	-0.313***	-0.304***
	[0.073]	[0.062]	[0.050]	[0.050]	[0.089]	[0.073]
Log number of competitors	-0.074***	-0.035**	-0.067***	-0.053***	-0.055***	-0.057***
	[0.013]	[0.017]	[0.012]	[0.012]	[0.013]	[0.017]
Log number of all originations			-0.046***			
			[0.007]			
Log of originated loans by all lenders				-0.050***		
				[0.006]		
Log number of all applications					-0.033***	
					[0.010]	
Log number of subprime applications	-0.013**	-0.074***				-0.014***
	[0.006]	[0.019]				[0.005]
Year = 2001	0.104***	0.096***	0.127***	0.135***	0.019*	0.110***
	[0.006]	[0.005]	[0.005]	[0.005]	[0.010]	[0.006]
Year = 2002	0.053***	0.051***	0.082***	0.092***	-0.035***	0.060***
	[0.008]	[0.006]	[0.007]	[0.007]	[0.009]	[0.007]
Year = 2003	0.104***	0.150***	0.137***	0.147***	0.01	0.110***
	[0.009]	[0.016]	[0.009]	[0.009]	[0.009]	[0.009]
Year = 2004	0.100***	0.166***	0.106***	0.115***	-0.023***	0.112***
	[0.011]	[0.022]	[0.008]	[0.008]	[0.006]	[0.012]
Year = 2005	0.095***	0.148***	0.104***	0.112***	-0.033***	0.110***
	[0.012]	[0.019]	[0.010]	[0.010]	[0.005]	[0.014]
Year = 2006	0.110***	0.142***	0.117***	0.125***	0	0.108***
	[0.012]	[0.015]	[0.010]	[0.010]	[0.000]	[0.011]
Constant	5.996***	4.679***	5.181***	4.975***	5.094***	4.918***
	[0.910]	[0.747]	[0.616]	[0.613]	[1.132]	[0.953]
Excluded instruments		Log number of prime loan applications				Proportion of Evangelicals* Rapture index
F-test of excluded instruments (p-value)		0.000***				0.000***
Observations	2646	2646	2646	2646	2267	2646
Number of MSAs	379	379	379	379	379	379
R-squared	0.43	0.4	0.44	0.45	0.40	0.40

Notes: Dependent variable 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 regressions (3) and (4), log number of originations and log volume of originated loans, respectively, are used instead of log number of applications. In regression (5), house price appreciation is replaced with its lagged value. In regression (6), the interaction of the proportion of evangelicals in the MSA and the rapture index is used as an instrument for house price appreciation. For detailed variable definitions, see Table 2. Regressions (1), (3), (4), and (5) are estimated using OLS and regressions (2) and (6) are 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. Time and Size Effects

Dependent variable: Denial rate	Time trend (1)	Fed fund rate (2)	Time trend and Fed fund rate (3)	Market size (4)
House price appreciation	-0.322***	-0.285***	-0.295***	-0.310***
	[0.025]	[0.025]	[0.025]	[0.025]
Average income	-0.003**	-0.004***	-0.004***	-0.003**
	[0.001]	[0.001]	[0.001]	[0.001]
Income growth	0.096**	0.072	0.07	0.07
	[0.045]	[0.044]	[0.044]	[0.045]
Unemployment rate	0.004**	0.006***	0.006***	0.005**
	[0.002]	[0.002]	[0.002]	[0.002]
Self employment rate	-0.311**	-0.081	-0.091	-0.210*
	[0.121]	[0.122]	[0.122]	[0.121]
Log population	-0.314***	-0.357***	-0.330***	-0.213***
	[0.050]	[0.048]	[0.049]	[0.054]
Log number of competitors	-0.062***	-0.076***	-0.071***	-0.069***
	[0.012]	[0.012]	[0.012]	[0.012]
Log number of applications	-0.025***	-0.032***	-0.029***	0.141***
	[0.007]	[0.007]	[0.007]	[0.029]
Log number of applications * Time trend	-0.001***		-0.001**	
	[0.000]		[0.000]	
Log number of applications * Fed fund rate		0.004***	0.003***	
		[0.000]	[0.000]	
Log number of applications * Log population				-0.013***
				[0.002]
Year = 2001	0.126***	0.195***	0.198***	0.112***
	[0.006]	[0.010]	[0.011]	[0.005]
Year = 2002	0.088***	0.208***	0.216***	0.060***
	[0.009]	[0.018]	[0.018]	[0.006]
Year = 2003	0.151***	0.284***	0.298***	0.109***
	[0.012]	[0.021]	[0.022]	[0.009]
Year = 2004	0.146***	0.256***	0.280***	0.091***
	[0.015]	[0.020]	[0.023]	[0.008]
Year = 2005	0.158***	0.187***	0.222***	0.088***
	[0.019]	[0.014]	[0.021]	[0.010]
Year = 2006	0.185***	0.146***	0.192***	0.107***
	[0.022]	[0.011]	[0.022]	[0.010]
Constant	5.134***	5.609***	5.212***	3.894***
	[0.632]	[0.601]	[0.623]	[0.676]
Observations	2646	2646	2646	2646
Number of MSAs	379	379	379	379
R-squared	0.44	0.45	0.45	0.45

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 interacted with a time trend. In regression (2), log number of applications is interacted with the Fed fund rate. In regression (3), both regression terms used in regressions (1) and (2) are included. In regression (4), log number of applications is interacted with log population. 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 9. Market and Boom Size

		Subprime lenders	
	All MSAs	Only MSAs with the number of applications exceeding the median	Only MSAs with both the number of applications and the growth in number of applications exceeding the median
Dependent variable: Denial rate	(1)	(2)	(3)
House price appreciation	-0.308***	-0.299***	-0.228***
	[0.025]	[0.026]	[0.064]
Average income	-0.004**	-0.002	0
	[0.001]	[0.002]	[0.003]
Income growth	0.100	0.074	0.317***
	[0.087]	[0.086]	[0.096]
Unemployment rate	0.003*	0.008***	0.012***
	[0.002]	[0.002]	[0.004]
Self employment rate	-0.311**	-0.198	0.066
	[0.130]	[0.124]	[0.338]
Log population	-0.353***	-0.175**	-0.252**
	[0.074]	[0.079]	[0.115]
Log number of competitors	-0.069***	-0.063***	-0.113***
	[0.012]	[0.014]	[0.029]
Log number of applications	-0.030***	-0.041***	-0.040***
	[0.008]	[0.009]	[0.015]
Year = 2001	0.116***	0.110***	0.117***
	[0.006]	[0.007]	[0.009]
Year = 2002	0.067***	0.048***	0.059***
	[0.008]	[0.009]	[0.013]
Year = 2003	0.118***	0.097***	0.107***
	[0.010]	[0.011]	[0.018]
Year = 2004	0.099***	0.071***	0.081**
	[0.009]	[0.011]	[0.036]
Year = 2005	0.098***	0.068***	0.074***
	[0.011]	[0.013]	[0.024]
Year = 2006	0.114***	0.085***	0.126***
	[0.012]	[0.013]	[0.036]
Constant	5.749***	3.506***	4.682***
	[0.913]	[0.991]	[1.515]
Observations	2646	2168	1158
Number of MSAs	379	354	354
R-squared	0.44	0.47	0.56

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. Regression (1) is the same as the one in Table 4, column 3, reproduced here for easy comparison. Regression (2) uses only the observations where the number of applications in the MSA exceed the sample median of 11,000. Regression (3) uses only the observations where both the number of applications and the growth in number of applications exceed the sample medians (11,000 and 13 percent for MSAs with number of applications above median, respectively). 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. 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 11. Alternative Measures of 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	0.60

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 12. Securitization, Lending Standards, and Mortgage Market Expansion

	Dependent variable: Denial rate		Dependent variable: Credit-to-income ratio	
	Prime lenders	Subprime lenders	Prime lenders	Subprime lenders
	(1)	(2)	(3)	(4)
House price appreciation	-0.122***	-0.269***	0.003	0.009*
	[0.015]	[0.026]	[0.016]	[0.005]
Average income	-0.004***	-0.002	-0.002**	-0.001***
	[0.001]	[0.001]	[0.001]	[0.000]
Income growth	0.025	0.096	-0.079*	-0.003
	[0.033]	[0.083]	[0.042]	[0.007]
Unemployment rate	0.001	0.004*	0	0.001***
	[0.001]	[0.002]	[0.001]	[0.000]
Self employment rate	0.112	-0.271**	-0.141**	-0.037**
	[0.079]	[0.130]	[0.064]	[0.017]
Log population	-0.296***	-0.256***	0.142***	0.045***
	[0.041]	[0.078]	[0.044]	[0.009]
Log number of competitors	0.009	-0.057***	0.005	0.017***
	[0.008]	[0.012]	[0.004]	[0.002]
Log number of applications	0.034***	-0.032***	0.110***	0.011***
	[0.006]	[0.009]	[0.004]	[0.001]
Denial rate			-0.030*	-0.036***
			[0.017]	[0.003]
Proportion of loans sold	-0.226***	-0.123***	0.129***	0.002
	[0.020]	[0.030]	[0.012]	[0.003]
Proportion of loans sold * Year >= 2004	0.076***	-0.110***	-0.015	0.026***
	[0.017]	[0.026]	[0.013]	[0.003]
Year = 2001	-0.063***	0.126***	-0.011***	-0.001
	[0.004]	[0.007]	[0.003]	[0.001]
Year = 2002	-0.079***	0.080***	-0.012***	-0.004***
	[0.005]	[0.009]	[0.004]	[0.001]
Year = 2003	-0.106***	0.129***	-0.010**	-0.003***
	[0.007]	[0.011]	[0.005]	[0.001]
Year = 2004	-0.104***	0.146***	-0.025***	-0.005***
	[0.010]	[0.013]	[0.006]	[0.001]
Year = 2005	-0.050***	0.138***	-0.017***	-0.005***
	[0.010]	[0.013]	[0.006]	[0.001]
Year = 2006	-0.028***	0.146***	-0.017***	-0.008***
	[0.010]	[0.013]	[0.006]	[0.001]
Constant	3.838***	4.444***	-2.717***	-0.715***
	[0.508]	[0.972]	[0.549]	[0.112]
Observations	2651	2646	2651	2646
Number of MSAs	379	379	379	379
R-squared	0.74	0.45	0.79	0.66

Notes: Dependent variable in regression (1) is the weighted-average denial rate of prime 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 subprime mortgage lenders, weighted by the size of each institution in terms of number of loan applications received. Dependent variable in regression (3) is the ratio of loans originated by prime mortgage lenders to total income. Dependent variable in regression (4) 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 (3) and that for subprime mortgage lenders in regression (4). 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%.

Figure 1. A Credit Boom Gone Bad?

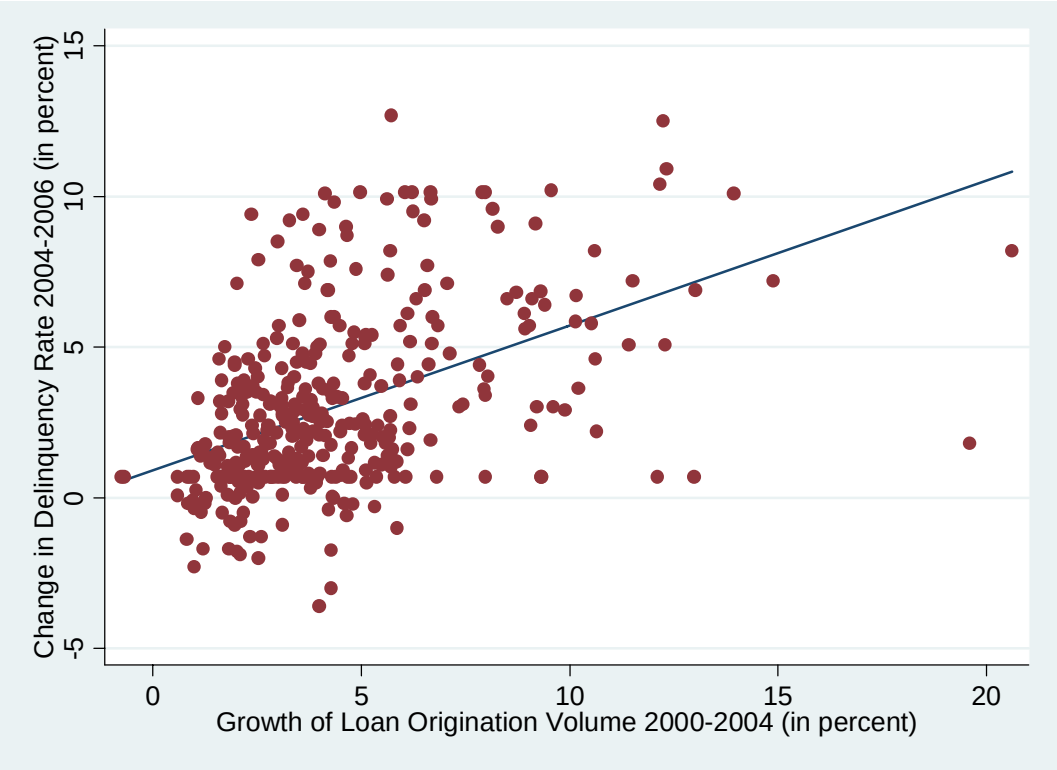
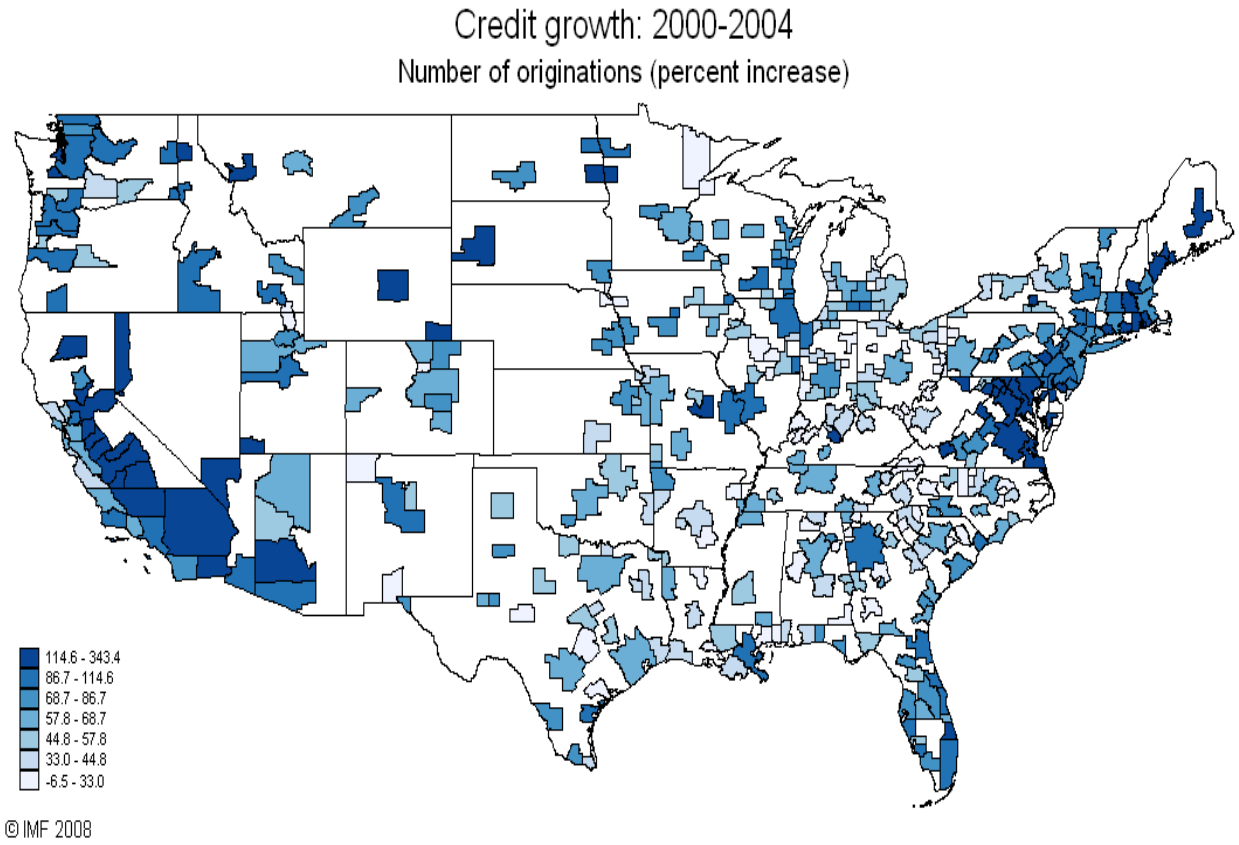


Figure 2. Subprime Mortgage Boom Across the Nation



Note: Data available for MSAs only.

Figure 3. House Prices and Credit Boom

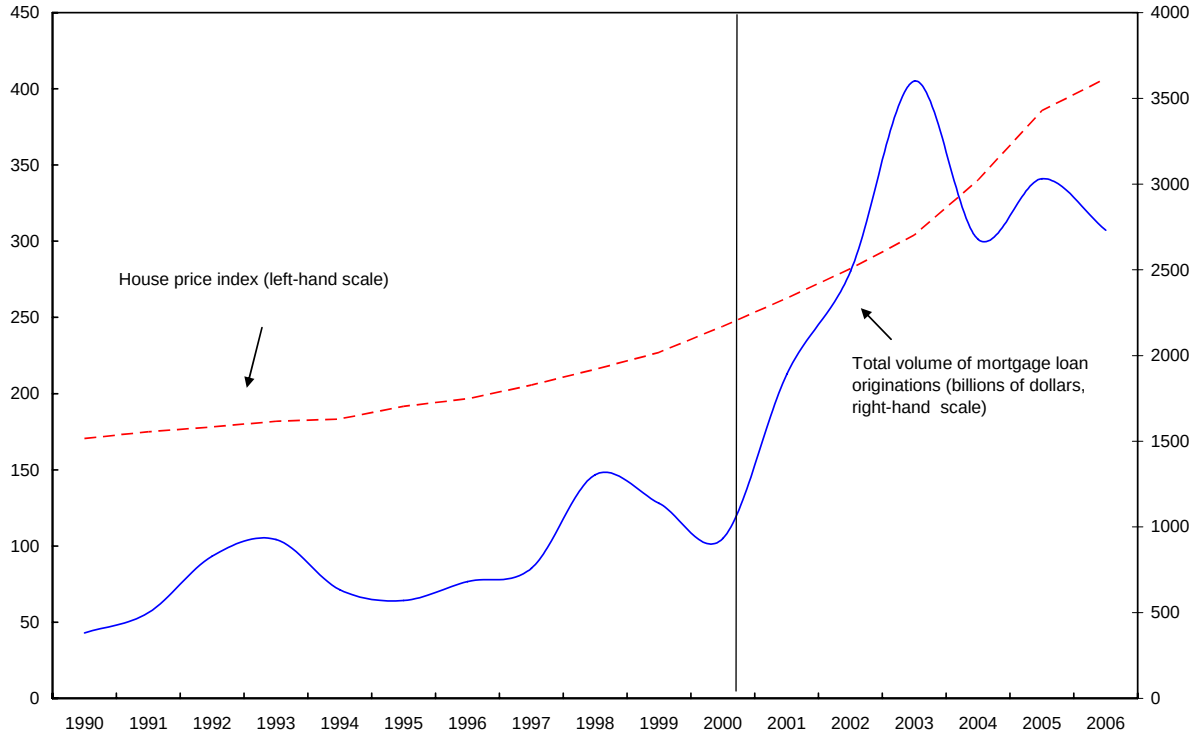


Figure 4. Lending Standards and Subprime Credit Boom