Fourth BI-CEPR Conference on Money, Banking and Finance

CORPORATE GOVERNANCE, CAPITAL STRUCTURE AND
FIRM PERFORMANCE

Rome, 2-3 October 2009

Lender Behavior During Credit Cycles

*Giovanni Dell'Ariccia, Deniz Igan and Luc Laeven

LENDER BEHAVIOR DURING CREDIT CYCLES[*]

Giovanni Dell'Ariccia
(IMF and CEPR)

Deniz Igan
(IMF)

Luc Laeven
(IMF, Tilburg University, CEPR, and ECGI)

Preliminary and incomplete

Abstract: The recent increase in mortgage delinquencies and the resulting financial turmoil have put the US financial system on trial. In particular, lenders have been accused of having engaged in a reckless expansion of credit to borrowers that had no capacity to repay their debt. We examine how strategic interaction among lenders led to a decrease in mortgage denial rates in the context of the recent credit boom. We show that the pace of credit growth by competitors led lenders to grant loans more liberally, resulting in a race to the bottom in credit quality. Moreover, less capitalized lenders appear to have behaved more aggressively in their lending decisions. These findings offer evidence of the disciplining role of capital requirements and point to a potential role for regulatory responses to cyclical competitive pressures.

Keywords: *Credit cycles, mortgage market, lending standards, bank regulation*
JEL classifications: G21, E51

---

1. INTRODUCTION

Increasing mortgage delinquencies and the resulting financial turmoil have put the US financial system on trial. In particular, lenders have been accused of having engaged in a reckless expansion of credit to borrowers that had no capacity to repay their debt. Financial innovation, deregulation, and the widespread failure of the supervisory and regulatory frameworks have often been blamed as the culprits. In particular, several studies have identified the rapid expansion of securitization as an important factor behind the excessive decline in lending standards.[1] Less attention has been paid to how changes in market structure have affected lender behavior or to the role played by regulation. This paper attempts to fill that gap.

The structure of the US mortgage market has changed dramatically over the past decade. In particular, the entry of large, nation-wide active players has altered the competitive landscape of many local markets. The paper examines how these changes affected banks' lending behavior. The paper also investigates whether capital requirements played their traditional role in limiting risk-taking. More specifically, the main questions we seek to answer are: How did local market conditions and changes in local market structure affect banks in their decisions on whether or not to grant a loan? And in particular, how did the entry of national players affect local lenders? On regulation, did better-capitalized banks apply more stringent standards as theory predicts bank capital requirements perform their expected disciplining role in curbing excessive risk taking?

---

[1] For example, Mian and Sufi (2007) and Dell'Ariccia et al. (2008) provide evidence that lending standards declined more during the US mortgage boom than what was justified on the basis of an improvement in underlying economic conditions, while Keys et al. (2007) and Ashcraft and Schuermann (2007) argue that securitization played an important role in the expansion of the mortgage market.

We attempt to answer these questions by merging "demand-side" information from a detailed dataset on mortgage applications (HDMA) with "supply-side data on banks' balance sheets and income statements (Call Report files). We also employ demographic and "macro" information to control for the local economic conditions. Indeed, we conjecture that banks make lending decisions based not only on the characteristics of borrowers but also based on local economic factors and strategic interaction with their competitors. For instance, loan applications from potential borrowers with comparable characteristics could be denied in a poor location with little growth prospects, but be approved in a booming area with strong growth prospects and intense competition.[2] Our sample spans from 2000 to 2007 (corresponding to the period of particularly fast market expansion that preceded the crisis). Our panel has three dimensions: time (yearly data), markets (Metropolitan Statistical Areas), and lender.

We focus on an admittedly limited aspect of lending standards, the denial rate of new mortgage applications. The rationale for this choice is that, controlling for other factors such as borrower characteristics, underlying market structure, and local economic conditions, an increase (decrease) over time in the probability of a lender approving (rejecting) a loan application is a sign of loosening lending standards. This, however, is also a choice of necessity. The HDMA dataset, while very comprehensive (it essentially covers the universe of mortgage applications in the U.S.), lacks some important information for a more precise evaluation of lending standards, such as interest rates, FICO scores, and loan-to-value ratios. On the plus side, by relying on this dataset, we are able to exploit information on loans that were rejected in addition to mortgages that were

2

actually originated.

A caveat: the results in this version of the paper are to be considered incomplete and preliminary and should not be cited without permission from the authors. That said, the evidence so far suggests that competitive dynamics during the boom period led to a decline in denial rates that can be related to the recent increase in delinquencies. This is consistent with recent theories of competition under adverse selection (see next section for a discussion) linking credit expansion and lending standards to bank strategic behavior, and show that competitive pressures from peer banks played an important role. In particular, we find that denial rates tend to decline when the demand for loans is particularly strong. In previous work,[3] we had found robust evidence of a causal relationship between the growth rate of loan applications and denial rates within a MSA. In this paper, we are able to distinguish between the effects on a bank's denial rates of applications for its own loans and for those of its competitors. We find that strong application (and loan origination) growth at competing banks leads lenders to decrease denial rates. On the contrary, a strong demand for its own loan leads a bank to become more choosy and reject a larger fraction of applications.

We also find that bank-level variables "dominate" geographical variables variables. Most MSA-level variables are consistently significant, but there effect may be economically relatively small. For example, a lender's nationwide denial rate appears to explain a large portion of the denial rate variability. This may explain why it is hard to find a significant effect for changes in local competitive conditions. Consistent with popular stories blaming the drop in lending standards on competitive pressures due to the

---

[2] Such behavior would be consistent with the procyclical movement in credit discussed in Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Lown and Morgan (2006), among others.

entry of nationwide competitors into local markets, we find a negative coefficient on various variables proxing for entry activity. These coefficients, however, are never significant once controlling for other factors.

Finally, capital appears to have played its expected disciplining role in the sense that less capitalized lenders behaved more aggressively in their lending decisions.[4] This finding offer evidence of moral hazard behavior on the part of banks with relatively low capital.

The preliminary nature of the analysis calls for caution when it comes to policy implications. So far, the results in the paper support the view that competitive dynamics during upswings lead banks to take more risk. In that context, the findings in the paper are supportive of proposals for reform aimed at reducing the procyclicality of the current regulatory framework. Adding a macroprudential dimension to banking regulation could be a step in this direction. For example capital requirements could be linked to aggregate credit growth, reducing the effects of the cycle on risk taking documented in this paper.

The rest of the paper is organized as follows. Section 2 summarizes the related literature on bank lending and credit booms. Sections 3 and 4 describe the data in detail. Section 5 lays out the empirical strategy. Section 6 presents the empirical results. Section 7 concludes.

2. RELATED LITERATURE

Several studies examine the interaction between the macroeconomic cycles and fluctuations in bank credit (Bernanke and Lown, 1991, Peek and Rosengren, 2000, Black

---

[3] Dell'Ariccia, Igan, and Laeven (2008).

and Strahan, 2002, and Calomiris and Mason, 2003). However, evidence on how lending standards are related to credit cycles has been limited. 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. Dell'Ariccia, Igan, and Laeven (2008) find that denial rates on mortgage applications tend to decline in areas where applications are growing faster.

A few recent papers have looked at the recent credit boom from a house-price perspective (Himmelberg et al., 2005, and Case and Shiller, 2003). The literature on mortgages has instead largely focused on issues of credit access and discrimination and on what determines access to subprime versus prime lenders. Munnell et al. (1996) shows that race has played an important, although diminishing, role in the decision to grant a mortgage. Pennington-Cross (2002) studies how local risk factors affect the fraction of the market that uses subprime lending. Other papers 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).

Securitization has been the subject of several papers in the wake of the crisis in the mortgage-backed securities market. Loutskina and Strahan (2007) shows how securitization affects the supply of loans 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

---

[4] Policy makers have long argued that bad loans are made at the peak of the business cycle and, more recently, talks on the need to rethink the procyclicality of capital regulation have intensified (e.g., Ayuso et

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. In particular, two papers by Dell'Ariccia and Marquez (2006) and Gorton and He (2008) have linked credit expansion and lending standards to bank strategic behavior. In both papers, an increase (decrease) in the demand for loans may trigger a switch in the competitive equilibrium toward a greater (smaller) supply of credit and lower (higher) lending standards. They also show that the threat of entry by low-cost competitors also can lead to a decline in lending standards.

3. DATA

We combine data from several sources. Our main set of data consists of economic and demographic information on applications for mortgage loans. We complement this dataset using balance sheet and income statement information from bank's Call Report filings. We further augment the dataset using additional information on the local and national economic environment using census data and other data sources.

---

al., 2004 and Repullo and Suarez, 2008).

Our main data source is the Home Mortgage Disclosure Act (HMDA) database. 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. Consequently, 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 loans, 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 (e.g. a mortgage company that does not accept deposits but raises funds for lending by borrowing in the capital markets) with at least ten percent of loan portfolio composed of home purchase loans must report HMDA data if it has originated more than 99 home purchase or refinancing loans on a property located in an MSA, and 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 reporting requirements. Therefore, information for rural areas tends to be incomplete. Yet urbanization rates (proportion of the population that lives in metropolitan areas) in the U.S. hover around 80 percent and comparisons of the total amount of loan originations in HMDA and industry sources indicate that 90 percent of the mortgage lending activity is covered by the database (Table 1).

Our coverage of HMDA data starts in 1996 and ends in 2007. This sample period covers a full credit cycle (Figure 1). Robust expansion of credit to the private sector

started in 1995, peaked in 1998, and decreased considerably between 1999 and 2000 to peak again in 2003. The more recent market contraction, which continues to this day, started in 2006.

The HMDA database consists of applications for residential housing loans received by the reporting lenders. A typical observation in a given year contains information on the location of the property and whether it is owner-occupied or not, the name of the lender and the name of its supervisory agency, and the characteristics of the borrower (income, gender, race) and of the loan (amount, purpose, GSE-insured or not). The observation also reports the action taken on the application (denied, approved, withdrawn by applicant, deemed incomplete by lender) and, for those loans that were originated, whether the loan was sold to a third party.

We remove some observations with missing data from the sample and also focus on the subset of loans that are either approved or denied. The criteria we apply for this data cleaning process are as follows. First, we drop applications with loan amounts smaller than 1,000 dollars because loan values are reported in units of thousands of dollars and values smaller than this amount are rounded up to the nearest number. Second, we eliminate applications where the applicant income is missing or is exactly 10,000 dollars as the reported applicant income is censored at this number. Third, we concentrate on single-family homes only and exclude loans for multi-family purpose from the sample as these properties are likely to have different market dynamics. Fourth, we drop federally insured loans. Finally, we eliminate all records that did not end in one of the following three actions: (i) application approved and loan originated, (ii)

8

application approved but loan not originated, or (iii) application denied.[5]

After the cleaning procedure, our data set includes 15,614 depository and nondepository institutions supervised by one of six agencies: Federal Reserve System (FRS), Federal Deposit Insurance Corporation (FDIC), Office of the Comptroller of the Currency (OCC), National Credit Union Administration (NCUA), Office of Thrift Supervision (OTS), Department of Housing and Urban Development (HUD). We summarize the activities of these lenders in each MSA in variables such as the denial rate on received applications, loan-to-income ratio on originated loans, and the proportion of loans that were sold within one year of origination. Hence, we end up with a data set where observations in each year are identified by lender and MSA pairs. This aggregation strategy, as opposed to the alternative of summarizing the information from applications at the lender level alone, allows us to explore whether the same lender exhibits different lending behavior in different MSAs. In total, we have 280,075 unique lender-MSA pairs and 841,301 observations.

Using the data from HMDA, we construct several additional MSA-level variables to account for the characteristics of the residential mortgage market the lender faces in a particular MSA, including the loan-to-income ratio of a typical application and the number of competing lenders. 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.

To explore how lender characteristics such as their financial position, size, and

---

[5] Other actions represent dubious cases, e.g., application withdrawn by applicant, or could lead to double-counting such as in the case of loans purchased from other financial institutions.

capital ratios affect loan activity, we combine the mortgage lending information disseminated through HMDA with annual balance sheet and income statement information provided in each bank's Report of Condition and Income, also known as the Call Reports, obtained from the database maintained by the Federal Reserve Bank of Chicago. In the period between 1996 and 2006, there are 12,580 banks, regulated by FRS, FDIC, and OCC, that submitted these reports.

The matching between the HMDA and Call Report databases is done in two steps. First, we use the identification numbers each of the three agencies assign to the lenders reporting them HMDA data. These numbers correspond to the identification codes RSSD9001 for FRS-regulated lenders, RSSD9050 for FDIC-regulated lenders, and RSSD9055 for OCC-regulated lenders in the Call Report database. Following this first round of "automated" matching which successfully matches 7,448 lenders, we do a manual check on the unmatched institutions. This second round matches another 408 lenders based on lender name and parent institution information.

The merged data set consists of commercial banks and savings institutions regulated by one of three agencies (FRS, FDIC, OCC) and that have made a housing-related loan in an MSA. The number of lenders in this restricted sample is 7,856. These lenders received loan applications in a total of 380 MSAs. Reflecting the fact that not all lenders are active in all MSAs, the merged data set is composed of 57,709 unique lender-MSA pairs.[6] The data set spans a total of 11 years from 1996 to 2006, generating a total number of lender-MSA-year observations equal to 193,912. For the lenders in this sample, we gather information on assets, weight of residential real estate lending activity in the overall portfolio, and CAMEL indicators (capital adequacy, asset quality,

managerial efficiency, earnings profitability, and liquidity).

We further supplement the data set 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). Table 2 presents the name, definitions, and sources of the variables we use.

We describe the data for three groups of lenders: (i) all institutions that are in the HMDA database, (ii) institutions that are only in the HMDA database and have no match in the Call Reports database, and (iii) institutions that are in both databases. Tables 3 to 5 present the descriptive statistics for each group at the lender, MSA, and lender-MSA levels.

4. SUMMARY STATISTICS

The summary statistics in Table 5 for the sample of financial institutions that are in both databases reveal a number of striking features of the data.

Let's first take a look at the lender-level variables. The summary statistics indicate that recourse to asset securitization has been widespread across lenders. The fraction of loans sold by lenders averages around 49 percent over the sample period. Capital stood at about 10 percent of risk-weighted assets, in excess of minimum

---

[6] In fact, the average number of MSAs a lender is active in is 7 while the median number is only 2.

standards, with Tier I capital making up 80 percent of capital and Tier I capital making up 20 percent of capital for the average bank. Nonperforming loans were low over the sample period, averaging about 1 percent of total loans. Banks were mostly profitable and liquid over the sample period, with return on assets averaging 3 percent and liquid assets representing about 8 percent of total assets on average. The size of the average bank in the sample was small with total assets of about 2.1 billion U.S. dollars. Exposure to real estate was substantial for most banks, with loans secured by real estate making up about 59 percent on average of banks' total loan portfolio. Loan denial rates were substantial, with denials at the MSA level averaging about 21 percent of total loan applications.

Next, let's take a look at the MSA-level variables. Denial rates for mortgage loans averaged about 21 percent, meaning that one in five loan applications was rejected, though denial rates varied a great deal across MSAs, from a low of 4 percent to a high of 60 percent. The total number of loans applications in an MSA averaged about 16 thousand per year, though this number varies across MSAs, from a low of 11.9 thousand applications per year to a maximum of 701 thousand applications per year. The number of competitors in an MSA averaged about 219 institutions. The MSA-level Herfindahl index, measured in terms of total loans originated, is about 0.05, indicating that market concentration is low. House price appreciation has been substantial, averaging about 6.4 percent per year across MSAs over the sample period. Unemployment has been relatively low in most MSAs, averaging about 4.8 percent over the sample period.

Finally, let's take a look at the lender-MSA level variables. The average loan-to-income ratio across lenders and MSAs is about 1.8. The market share of the average lender in a given MSA, defined as the proportion of loans originated by the lender tot

total originated loans in a given MSA on a volume basis, is about 1.3 percent, though it is as high as 98 percent in one case. The weight of the typical MSA in the lender's portfolio averages about 23 percent, and is as high as 100 percent, indicating that the lending operations of most institutions is concentrated in a small number of MSAs.

5. METHODOLOGY

We employ a reduced-form regression framework borrowed directly from the literature and apply it to our three-dimensional data set to identify the factors that affect lenders' decision to approve loans. Specifically, we extend the estimation procedure developed by Munnell et al. (1996) to our three-dimensional setting. Our main specification is:

$$DR_{ijt} = a_t + \gamma_{ij} + \beta_1 X_{it} + \beta_2 Y_{jt} + \beta_3 Z_{ijt} + \varepsilon_{ijt} \qquad (1)$$

where DR_{ijt} is the denial rate on the applications lender i receives in geographical area j at time t, X_{it} is a set of variables varying over time and across lenders, Y_{jt} is a set of variables varying over time and across geographical areas, Z_{ijt} is a set of variables varying across all three dimensions (time, area, and lender), a_t denotes year fixed effects, and γ_{ij} are "bi-dimensional fixed effects" for each lender-area pair.[7] As unit of observation for each geographical area we use the metropolitican statistical area (MSA).

The main variable we include to control for differences among lenders is the size of the lending institution, as measured by the log of assets. When we analyze the restricted sample of those lenders that file both Call Report and HMDA data, we also include indicators of the lender's capital adequacy, asset quality, managerial efficiency, earnings profitability, and liquidity. We refer to Table 2 for a list and definition of these

lender-specific variables.

In terms of variables that capture differences in the geographical dimension only, we include house price appreciation, average area income, area income growth, unemployment and self-employment rates, population and the number of competing lenders. Finally, for variables spanning all three dimensions of time, lender, and area, we use credit boom measures and securitization activity by the lender on the loans originated in that particular area. Securitization activity is measured by the proportion of originated loans sold.

In most specifications, we include the average denial rate for each lender for the subset of areas in which the lender is active as a regressor. The idea is to study whether lenders followed similar, nationwide strategies or adopted their lending behavior to local market conditions. The coefficient linking these two denial rates measures the degree to which lender behavior in a given area is associated with the average behavior of the lender across the nation.

Finally, we focus on entry. We run three different specifications to capture the effect of entry activity on denial rates. In the first, we augment our main specification with a dummy entry taking the value 1 if a lender is new to a MSA. This specification focuses on the loan approval behavior of new entrants. Second, we turn to the effects on the denial rates of incumbents. We build two measures as proxies for entry activity into a local market. The first is the simple ratio of the number of new entrants to existing competitors. The second is the market share of new entrants that belong to the top 20 nationwide banks. We then use these measures in specification that excludes the entrant

---

[7] In alternative specifications, we also consider other bi-dimensional fixed effects, i.e., dummy variables assigned to area-time and lender-time pairs.

themselves from the regression.

6. RESULTS

Results from our baseline regression specification are reported in Table 6. The dependent variable is the denial rate at the lender-MSA level. Regressions are estimated using OLS, though estimation using a truncated regression model generates qualitatively similar results. All regressions include year and lender-MSA fixed effects (not reported) and standard errors are corrected for heteroskedasticity using White's procedure.

The first column in Table 6 covers all the lenders in the HMDA dataset. The second is restricted to those for whom information is also available in the Call Report files. Starting with MSA-level variables, all macroeconomic variables enter with the expected signs (although not all are significant). Denial rates tended to be lower in metropolitan areas characterized by higher income growth, a lower unemployment rate, and a lower self-employment rate (self-employment is typically associated with a riskier income profile). Denial rates were also lower in larger MSAs (typically large cities) and in areas with fast rising housing prices. This 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.

Turning to lender-MSA specific variables, securitization appears to have had an effect on lender behavior to the extent that denial rates were negatively related to the share of loans each lender sold in a particular MSA. In other words, denial rates were lower in areas where securitization was more widespread. This result is consistent with earlier work by Keys et al. (2007), Mian and Sufi (2007), and Dell' Ariccia et al. (2008) who showed that the increasing recourse to asset securitization helped fuel the mortgage

15

crisis and contributed to the decline in denial rates. Lenders that catered to borrowers with high loan-to-income ratios, typically corresponding to riskier borrowers, tended to have higher denial rates, as one would expect, given that we already control for the average income of the borrowers.

With regard to our main variables of interest, we find that denial rates tended to decline with the number of loan applications. More precisely, denial rates tended to drop in regions where applications increased, as measured by the log number of applications to other lenders in MSA variable, but increased with the number of applications at each individual lender. The overall effect of an increase of loan applications on denial rates is strongly negative as the first effect outweighs the second effect, and the difference is statistically significant. These results are consistent with theoretical predictions that adverse selection problems decrease as a large number of previously unbanked borrowers enter the market, while at the same time banks become more choosy as the number of potential clients rises (see, e.g., Dell'Ariccia and Marquez, 2006). Also consistent with adverse selection explanations, we find that lenders with larger market shares tended to be less choosy, as reflected in lower denial rates.

Finally, we turn to lender specific variables. Bank size, as measured by the logarithm of the lender's total assets, mattered, in the sense that smaller lenders tended to have higher denial rates. This is consistent with the view that saw large nationwide lenders (such as Countrywide) as the main culprits. In that context, a lender's nationwide denial rate appears to have played a critical role (and explains a relatively large portion of the dependent variable variability).

In the second column of Table 6, we augment the model with one-year lagged

16

lender-specific variables based on their balance sheet and income statement information. These variables include measures of the lender's capital adequacy, asset quality, efficiency, profitability, and liquidity. This necessarily restricts the sample to institutions covered in the Call Report files (that said, results for the specification in column 1 are confirmed in this more restricted sample).

We find that more capitalized banks tended to have higher denial rates than their less capitalized counterparts, indicating that well-capitalized banks were more selective in their decisions to grant loans. More efficient and more liquid banks practiced lower denial rates (although the coefficient for liquidity is not significant), consistent with lower funding costs. Profitability and asset quality do not appear to have influenced denial rates. Most of the other variables in the regressions maintained the same sign and significance as in the previous regression (the main exception is the coefficient for the unemployment rate that is no longer statistically significant).

All these results are qualitatively unchanged when we lag the loan application variables one year to reduce concerns about simultaneity bias, except that the size of the coefficients on both application variables is somewhat reduced (these regressions are not reported for brevity).

Table 7 reports the results of our attempt at estimating the effect of new entry on the denial rate of incumbents. We include three different variables proxying for new entry into an MSA: simple ratio of the number of new entrants to existing lenders, the ratio of new large entrants (those in the top quartile of the asset distribution) to existing lenders,

and the market share of new entrants. All three variables have the expected negative coefficient, but they are not significant. Interestingly, however, entrants do have denial rates that are on average lower than incumbents, suggesting that they did play a role in the decline of lending standard.

7. CONCLUSIONS

Using detailed data on mortgage market activity and bank's financial statement reports, we document how lending behavior reacts to local economic conditions and underlying market structures. We show that strategic interaction among lenders plays an important role in affecting loan approvals at individual lending institutions. In particular, we find that: 1) the pace of credit growth by competitors leads lenders to decrease a bank's own denial rate; 2) new entrants tend to have lower denial rates, but do not appear to have had a negative effect on the incumbent standards; and 3) bank capital appears to play its expected disciplinary role, as better capitalized lenders behave less aggressively in their lending decisions.

These findings offer some evidence in support of recent theories of financial intermediation based on asymmetric information linking credit expansion and lending standards to bank strategic behavior. Moreover, they support the potential disciplining role of capital requirements and suggest that there may be cyclical a role for regulatory policy.

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.

Ayuso, Juan, Daniel Pérez and Jesus Saurina, 2004, Are Capital Buffers Pro-Cyclical? Evidence from Spanish Panel Data, Journal of Financial Intermediation 13, 249–264.

Berger, Allen and Gregory Udell, 2004, The Institutional Memory Hypothesis and the Procyclicality of Bank Lending Behavior, J*ournal of Financial Intermediation* 13, 458-495.

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

Bernanke, Ben and Cara Lown, 1991, The Credit Crunch, *Brookings Papers on Economic Activity* 2, 205-239.

Black, Sandra and Philip Strahan, 2002, Entrepreneurship and Bank Credit Availability, *Journal of Finance* 57(6), 2807-2833.

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

Calomiris, Charles and Joseph Mason, 2003, Consequences of Bank Distress during the Great Depression, *American Economic Review* 93(3), 937-947.

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, Deniz Igan, and Luc Laeven, 2008, Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market, CEPR Discussion Paper No. 6683, London, UK.

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

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

Gorton, Gary and Ping He, 2008, Bank Credit Cycles, forthcoming, *Review of Financial Studies*.

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, Vicente Salas, and Jesus Saurina, 2006, Determinants of Collateral, *Journal of Financial Economics* 81, 255-281.

Keys, Benjamin, Tanmoy Mukherjee, Amit Seru, and Vikrant Vig, 2007, Securitization and Screening: Evidence from Subprime Mortgage Backed Securities, mimeo, London Business School.

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.

Loutskina, Elena and Philip Strahan, 2007, Securitization and the Declining Impact of Bank Financial Condition on Loan Supply: Evidence from Mortgage Originations, *Journal of Finance*, forthcoming.

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

Mian, Atif, and Amir Sufi, 2007, The Consequences of Mortgage Credit Expansion: Evidence from the 2007 Mortgage Default Crisis, Quarterly Journal of Economics, forthcoming.

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

Peek, Joe and Eric Rosengren, 2000, Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States, *American Economic Review* 90, 30-45.

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

Petersen, Mitchell and Raghuram Rajan, 2002, Does Distance Still Matter: The Information Revolution in Small Business Lending, *Journal of Finance* 57, 2533-2570.

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

Repullo, Rafael and Javier Suarez, 2008, The Procyclical Effects of Basel II, mimeo, CEMFI.

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

Table 1. Coverage in HMDA

Year	Total volume of originations (trillions of dollars)		Coverage (percent)
	HMDA database	Whole market	
1996	0.709	0.785	90.30
1997	0.748	0.859	87.12
1998	1.355	1.430	94.77
1999	1.139	1.275	89.33
2000	0.915	1.048	87.35
2001	1.865	2.058	90.62
2002	2.575	2.675	96.27
2003	3.314	3.835	86.42
2004	2.560	2.810	91.11
2005	2.888	3.120	92.57
2006	2.605	2.980	87.41

Table 2. Definitions and Sources of Variables

Name	Definition	Source
Lender level		
Proportion of loans sold	Securitized loans as a percent of total originated loans by lender in all MSAs where it has activity	HMDA
Capital adequacy (Tier 1)	Ratio of Tier 1 capital to total risk-weighted assets	Call Report
Capital adequacy (Tier 2)	Ratio of Tier 2 capital to total risk-weighted assets	Call Report
Asset quality	Ratio of nonperforming loans to total loans	Call Report
Efficiency	Ratio of total income to total noninterest expense	Call Report
Profitability	Ratio of net income to total assets	Call Report
Liquidity	Ratio of liquid assets to total assets	Call Report
Size	Logarithm of total assets	Call Report
Real estate exposure	Ratio of loans secured by real estate to total loans	Call Report
Residential real estate exposure	Ratio of loans secured by 1-4 family residential properties to total loans	Call Report
Delinquent loan ratio in RRE portfolio	Proportion of loans past due 90 days and more in total loans secured by 1-4 family residential properties	Call Report
Nonaccrual loan ratio in RRE portfolio	Proportion of nonaccruing loans in total loans secured by 1-4 family residential properties	Call Report
Charge-off ratio on RRE loans	Ratio of charge-offs on loans secured by 1-4 family residential properties to total loans secured by 1-4 family residential properties	Call Report
MSA level		
Denial rate	Number of denied loan applications divided by the total number of applications to all lenders	HMDA
House price appreciation	Change in the house price index	OFHEO
Average income	Total MSA income divided by population	BEA
Income growth	Change in total MSA income	BEA
Unemployment rate	Number of unemployed as a percent of labor force	BLS
Self employment rate	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	Population in MSA (in log)	Census Bureau
Log number of competitors	Number of institutions accepting applications and extending loans in the MSA	HMDA
Log number of applications	Number of loan applications in the MSA	HMDA
Loan-to-income ratio	Average loan-to-income ratio on the loans originated in the MSA	HMDA
Herfindahl index	Sum of squares of markets shares of all lenders in the MSA (normalized to take on values between 0 and 1 with higher values indicating less competition), measured in terms of total loans originated	HMDA
Proportion of loans sold	Securitized loans as a percent of total originated loans	HMDA
Lender-MSA level		
Loan-to-income ratio	Average loan-to-income ratio on the loans originated by the lender in the MSA	HMDA
Denial rate	Number of denied loan applications divided by the total number of applications to the lender	HMDA
Log number of applications	Number of loan applications to the lender in the MSA	HMDA
Proportion of loans sold	Securitized loans as a percent of total originated loans by the lender	HMDA
Market share	Proportion of originated loans by the lender to total originated loans in the MSA (on volume basis)	HMDA
Weight of MSA in lender's portfolio	Proportion of loans originated by the lender in the MSA to all loans originated by the lender (on volume basis)	HMDA

Table 3. Descriptive Statistics: All Lenders in HMDA

Variable	Obs	Mean	Std. Dev.	Min	Max
Lender level					
Proportion of loans sold	841,301	50.03	6.18	10.92	64.54
Size	750,682	11.67	3.21	4.29	22.80
MSA level					
Denial rate	841,301	21.32	7.63	4.16	59.90
Denial rate, prime	841,301	20.75	7.56	4.11	60.33
Denial rate, subprime	839,104	39.99	12.91	0.00	100.00
Log number of applications	841,301	9.79	1.29	2.48	13.46
Log number of competitors	841,301	5.42	0.48	0.69	6.54
Herfindahl index	841,301	0.05	0.02	0.01	0.96
Proportion of loans sold	841,301	45.68	10.37	0.18	77.76
Loan-to-income ratio	841,301	1.58	0.31	0.80	2.93
House price appreciation	840,389	6.97	6.08	-9.17	40.94
Average income	841,301	29.53	6.80	11.54	71.90
GDP growth rate	841,301	5.32	2.84	-34.00	47.97
Unemployment rate	840,782	4.94	1.98	1.23	30.87
Self-employment rate	841,301	16.57	3.39	7.48	31.18
Log population	841,301	13.24	1.39	10.81	16.75
Lender-MSA level					
Loan-to-income ratio	750,718	1.90	0.88	0.00	90.60
Denial rate	841,301	22.57	30.33	0.00	100.00
Log number of applications	841,301	2.47	2.04	0.00	11.31
Proportion of loans sold	750,718	68.39	41.45	0.00	100.00
Market share	841,301	0.50	3.22	0.00	100.00
Weight of MSA in lender's portfolio	835,462	10.11	28.24	0.00	100.00

Table 4. Descriptive Statistics: Lenders only in HMDA

Variable	Obs	Mean	Std. Dev.	Min	Max
Lender level					
Proportion of loans sold	647,389	50.38	6.11	10.92	64.54
Size	570,238	10.74	2.59	4.29	22.80
MSA level					
Denial rate	647,389	21.39	7.55	4.16	59.90
Denial rate, prime	647,389	20.83	7.48	4.11	60.33
Denial rate, subprime	645,743	40.04	12.89	0.00	100.00
Log number of applications	647,389	9.82	1.28	5.64	13.46
Log number of competitors	647,389	5.43	0.48	0.69	6.54
Log number of applications, prime	647,389	9.79	1.29	5.64	13.43
Log number of competitors, prime	647,389	5.39	0.49	0.69	6.52
Log number of applications, subprime	645,743	5.96	1.48	0.00	9.76
Log number of competitors, subprime	645,743	2.11	0.46	0.00	3.14
Herfindahl index	647,389	0.05	0.02	0.01	0.96
Proportion of loans sold	647,389	45.83	10.29	0.18	77.76
Loan-to-income ratio	647,389	1.59	0.32	0.80	2.93
Subprime delinquency rate	211,105	9.96	3.93	1.70	35.80
House price appreciation	646,713	7.15	6.30	-9.17	40.94
Average income	647,389	29.59	6.88	11.54	71.90
GDP growth rate	647,389	5.36	2.84	-34.00	47.97
Unemployment rate	646,994	4.98	2.02	1.23	30.87
Self-employment rate	647,389	16.63	3.42	7.48	31.18
Log population	647,389	13.26	1.38	10.81	16.75
Lender-MSA level					
Loan-to-income ratio	568,791	1.95	0.91	0.00	90.60
Denial rate	647,389	23.12	31.42	0.00	100.00
Log number of applications	647,389	2.23	1.94	0.00	10.94
Proportion of loans sold	568,791	76.10	38.16	0.00	100.00
Market share	647,389	0.25	2.15	0.00	100.00
Weight of MSA in lender's portfolio	641,827	6.21	22.12	0.00	100.00

Table 5. Descriptive Statistics: Lenders both in HMDA and Call Report

Variable	Obs	Mean	Std. Dev.	Min	Max
Lender level					
Proportion of loans sold	193,912	48.87	6.25	10.92	64.54
Capital adequacy (Tier 1)	192,744	0.08	0.03	-0.01	1.51
Capital adequacy (Tier 2)	192,744	0.02	0.01	0.00	0.21
Asset quality	193,848	0.01	0.01	0.00	0.29
Efficiency	192,729	2.83	1.96	0.20	25.56
Profitability	192,744	0.03	0.02	0.00	5.25
Liquidity	193,909	0.08	0.09	-8.80	1.06
Size	180,444	14.60	3.24	9.21	21.28
Real estate exposure	193,909	59.48	23.01	0.00	100.00
Residential real estate exposure	192,743	34.67	21.15	0.00	100.00
Delinquent loan ratio in RRE portfolio	168,447	0.41	0.80	0.00	44.08
Nonaccrual loan ratio in RRE portfolio	168,447	0.57	1.00	0.00	79.78
Charge-off ratio on RRE loans	168,447	4.85	76.27	0.00	1329.63
MSA level					
Denial rate	193,912	21.10	7.89	4.16	59.90
Denial rate, prime	193,912	20.52	7.81	4.11	60.33
Denial rate, subprime	193,361	39.81	12.99	0.00	100.00
Log number of applications	193,912	9.71	1.32	2.48	13.46
Log number of competitors	193,912	5.39	0.49	0.69	6.54
Log number of applications, prime	193,912	9.68	1.32	2.48	13.43
Log number of competitors, prime	193,912	5.35	0.50	0.69	6.52
Log number of applications, subprime	193,361	5.86	1.49	0.00	9.76
Log number of competitors, subprime	193,361	2.13	0.47	0.00	3.14
Herfindahl index	193,912	0.05	0.03	0.01	0.96
Proportion of loans sold	193,912	45.16	10.63	0.18	77.76
Loan-to-income ratio	193,912	1.55	0.29	0.80	2.93
Subprime delinquency rate	55,912	10.56	3.63	1.70	35.80
House price appreciation	193,676	6.38	5.26	-9.17	40.94
Average income	193,912	29.34	6.54	11.54	71.90
GDP growth rate	193,912	5.19	2.82	-34.00	47.97
Unemployment rate	193,788	4.84	1.82	1.23	30.87
Self-employment rate	193,912	16.35	3.27	7.48	31.18
Log population	193,912	13.20	1.42	10.81	16.75
Lender-MSA level					
Loan-to-income ratio	181,927	1.77	0.77	0.00	55.88
Denial rate	193,912	20.75	26.29	0.00	100.00
Log number of applications	193,912	3.25	2.15	0.00	11.31
Proportion of loans sold	181,927	44.28	42.05	0.00	100.00
Market share	193,912	1.31	5.36	0.00	98.58
Weight of MSA in lender's portfolio	193,635	23.04	40.01	0.00	100.00

Table 6. Baseline Regressions

Dependent variable: Denial rate by lender in MSA

MSA factors

House price appreciation, lagged	-4.513***	-4.222***
	[1.177]	[1.198]
Average income	0.0621	0.0652*
	[0.0385]	[0.0390]
Income growth	-2.608*	-2.876**
	[1.405]	[1.410]
Unemployment rate	11.79*	9.782
	[6.046]	[6.174]
Self-employment rate	8.477*	8.271*
	[4.409]	[4.435]
Log population	-3.629**	-3.463**
	[1.656]	[1.681]
Log number of competitors	0.25	0.248
	[0.428]	[0.431]

Lender-MSA factors

Loan-to-income ratio	0.727***	0.735***
	[0.0881]	[0.0886]
Log number of applications to competing lenders in MSA	-0.574**	-0.579**
	[0.265]	[0.268]
Log number of applications to lender in MSA	0.625***	0.618***
	[0.0587]	[0.0600]
Proportion of loans sold by lender in MSA	-0.0182***	-0.0205***
	[0.00212]	[0.00213]
Market share of lender in MSA (lagged)	-0.0667***	-0.0644***
	[0.00764]	[0.00784]

Lender factors

|		
Size	-0.239***	-0.250***
	[0.0604]	[0.0644]
Nationwide denial rate	0.740***	0.726***
	[0.00670]	[0.00698]
Capital adequacy, lagged		19.22**
		[7.463]
Asset quality, lagged		7.502
		[5.820]
Efficiency, lagged		-0.216***
		[0.0734]
Profitability, lagged		4.594
		[8.587]
Liquidity, lagged		-0.00964
		[0.761]
Observations	129090	122954
R-squared	0.327	0.318
Number of id_md	36183	33548

Notes: Dependent variable in all regressions is the ratio of denied applications to all applications received by the lender in the MSA. The sample includes all lenders reporting HMDA data. For detailed definitions of the independent variables, see Table 2. All regressions are OLS and include year and lender-MSA fixed effects (not reported for brevity). Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Table 7. The Effects of Entry

Dependent variable: Denial rate by lender in MSA

MSA factors

House price appreciation, lagged	-4.228***	-4.235***	-4.219***
	[1.198]	[1.197]	[1.199]
Average income	0.0669*	0.0716*	0.0654*
	[0.0394]	[0.0392]	[0.0390]
Income growth	-2.909**	-2.984**	-2.883**
	[1.412]	[1.409]	[1.411]
Unemployment rate	9.827	9.963	9.774
	[6.176]	[6.179]	[6.177]
Self-employment rate	8.271*	8.396*	8.280*
	[4.435]	[4.437]	[4.437]
Log population	-3.472**	-3.553**	-3.472**
	[1.682]	[1.683]	[1.682]
Log number of competitors	0.261	0.333	0.246
	[0.436]	[0.438]	[0.431]
Proportion of new entrant lenders	-0.00294		
	[0.0110]		
Proportion of new entrant large lenders		-1.48E-05	
		[1.15e-05]	
Market share of lenders			-0.000332
			[0.00308]

Lender-MSA factors

Loan-to-income ratio	0.735***	0.735***	0.735***
	[0.0886]	[0.0886]	[0.0886]
Log number of applications to competing lenders in MSA	-0.567**	-0.529*	-0.578**
	[0.272]	[0.270]	[0.267]
Log number of applications to lender in MSA	0.618***	0.618***	0.618***
	[0.0600]	[0.0600]	[0.0600]
Proportion of loans sold by lender in MSA	-0.0205***	-0.0205***	-0.0205***
	[0.00213]	[0.00213]	[0.00213]
Market share of lender in MSA (lagged)	-0.0644***	-0.0642***	-0.0644***
	[0.00784]	[0.00784]	[0.00784]

Lender factors

Size	-0.250***	-0.250***	-0.250***
	[0.0644]	[0.0644]	[0.0644]
Nationwide denial rate	0.726***	0.726***	0.726***
	[0.00698]	[0.00698]	[0.00698]
Capital adequacy, lagged	19.21**	19.21**	19.22**
	[7.463]	[7.463]	[7.462]
Asset quality, lagged	7.469	7.333	7.499
	[5.820]	[5.820]	[5.821]
Efficiency, lagged	-0.216***	-0.216***	-0.216***
	[0.0734]	[0.0734]	[0.0734]
Profitability, lagged	4.604	4.634	4.591
	[8.587]	[8.587]	[8.586]
Liquidity, lagged	-0.0101	-0.0144	-0.00985
	[0.761]	[0.761]	[0.761]
Observations	122954	122954	122954
R-squared	0.318	0.318	0.318
Number of id_md	33548	33548	33548

Notes: Dependent variable in all regressions is the ratio of denied applications to all applications received by the lender in the MSA. The sample includes all lenders reporting HMDA data. For detailed definitions of the independent variables, see Table 2. All regressions are OLS and include year and lender-MSA fixed effects (not reported for brevity). Robust standard errors are in brackets. * denotes significance at 10%; ** significance at 5%; *** significance at 1%.

Figure 1. Total Mortgage Originations, 1995-2007
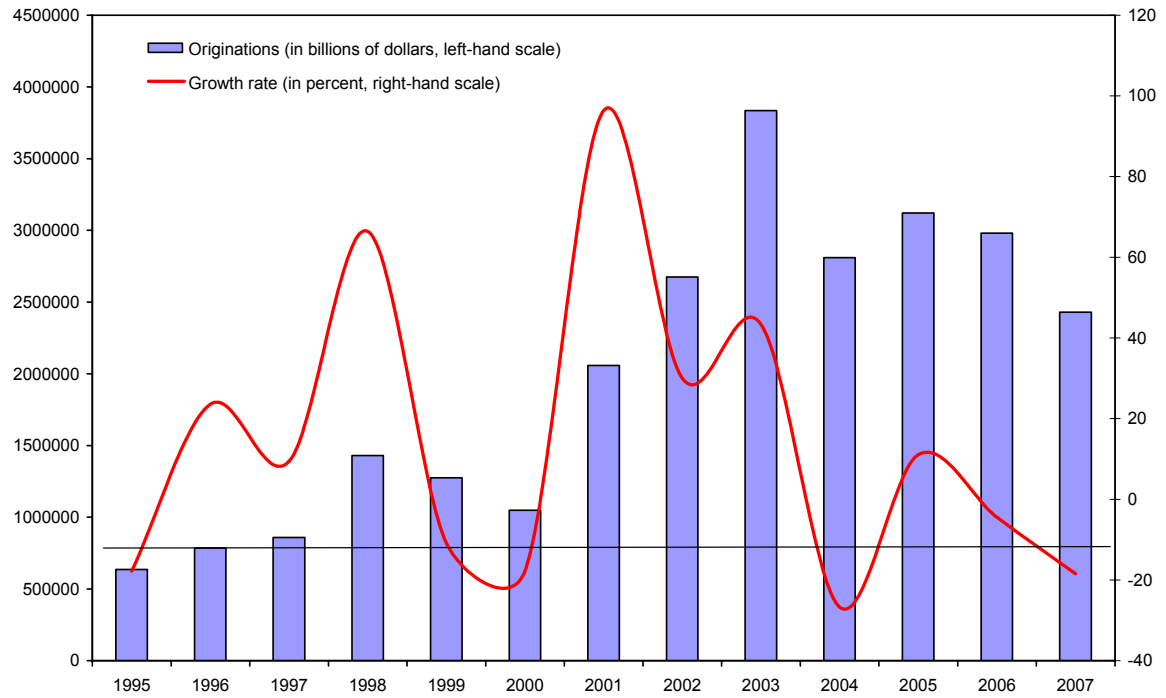
Source: Inside Mortgage Finance.