Essays on Banking

by

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B.A. in Economics & Business Administration
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Submitted to the Alfred. P. Sloan School of Management in Partial
Fulfillment of the Requirements for Degree of

Doctor of Philosophy
at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

February 2006

OCTOBER 2005

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Abstract

This thesis consists of two chapters that investigate two important issues in banking of the past decade: the effect of banking consolidation on the borrowers and the regulatory capital requirements for banks.

The first chapter analyzes the effect of bank mergers on loan prices, and the welfare implications for borrowers. In particular I test the hypothesis that mergers create efficiency gains which are, in fact, passed on to borrowers through a reduction in interest rates. The alternative hypothesis is that mergers lead to greater market concentration and in turn an increase in the cost of capital for borrowers. Using a proprietary loan-level data set for U.S. commercial banks, I find that acquiring banks, on average, reduce the spreads on their new commercial and industrial loans after a merger. The reduction in loan spreads is both larger and also more persistent for the smaller acquirers, with total gross assets less than $10 billion. These findings seem to be driven by cost efficiencies due to mergers, since the results are stronger for the sample of acquirers with larger than median declines in their operating costs after their mergers. Moreover, the reduction in spreads is much larger if the acquire and the target have some geographical overlap of markets before the merger, and, consequently, more potential for cost savings. However, if the market overlap is so extensive as to significantly increase market concentration, market power effects dominate and loan spreads, on average increase. The findings are robust to using variation in dates of intrastate banking deregulation as an exogenous instrument for the timing of the in-market mergers. Contrary to what might be expected, bigger acquire do not impose less favorable pricing terms for small businesses seeking to borrow. Indeed, the reduction in spreads is significant for small loans, showing that small borrowers typically pay lower interest rates to banks that have expanded during the previous few years through mergers.

The second chapter models the incentives of banks to undertake "Regulatory Capital Arbitrage" (RCA), under the current capital adequacy rules. RCA is a substitution of high-risk assets for low-risk assets with no requirement to increase their risk-based regulatory capital. I show that in equilibrium banks making risky investments pool with the banks investing safely so that they can be subject to a lower amount of regulatory capital because the risk exposures of banks cannot be precisely measured. The chapter examines whether the proposed "Basel II" regulatory system would be more or less efficient and effective than the current system. Under the Basel II rules, banks will have
an option to use their own internal risk assessment systems in determining their regulatory capital as long as they satisfy infrastructure requirements of the supervisors. I show that this Internal Ratings-based (IRB) Approach of Basel II can be interpreted as a way of forcing a separating equilibrium, in which good banks that do not pursue unduly risky strategies identify themselves to the regulators and are rewarded with a lower capital requirement. Such a separating equilibrium can only be sustained under an effective supervision system or by giving some incentives to the excessively risk-taking banks to stay in the current system rather than opting into the new IRB approach.

Thesis Supervisor: Stewart C. Myers
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Acknowledgements

When I was admitted to MIT as a PhD student, I felt like my dreams had come true. However, I now realize that that was only a start and it became complete only when I defended my thesis in front of my dream committee, Steve Ross, Stew Myers, and Antoinette Schoar. It was the experience of a lifetime to be advised by them and to be able to have research as well as non-research discussions with them. I hope that they will be lifelong mentors to me.

I am indebted to Steve for his continuous support, guidance and encouragement since my very first year at MIT. I feel lucky to have learned even a little bit from his exceptional talent in modeling difficult problems in the simplest possible way. He taught me how to differentiate the fundamental from the marginal and that the essence of solving a fundamental problem is being able to look at it in a simple way. I enjoyed every moment of our academic discussions as well as our chats, especially about his granddaughter.

I feel truly lucky to have had Prof. Myers as one of my supervisors. This thesis would not have been possible without his encouragement and helpful suggestions. His fundamental and challenging questions, illuminating the most crucial points, and his exceptionally deep intuition were truly inspiring. All our discussions were a continuous learning process for me. My profound thanks go to him for being a great mentor and for always being available to listen to my questions.

I would also like to thank Antoinette, whose outstanding talent for empirical work seemed almost magical to me. She taught me how important and challenging it is to accurately identify an empirical problem. I have always admired her knowledge of theory and literature and her exceptional way of addressing empirical questions. I am grateful to her both for always being available to discuss my research and also for her emotional support in personal issues.
I owe a lot to the intellectual and friendly atmosphere of MIT Sloan. Many thanks are due to my fellow PhD students, particularly to my office-mates, Igor, Jiro, and Dimitris. But especially I would like to thank Oguzhan for his valuable support and help throughout the PhD program. I also wish to thank Megan, Cathy, Melinda, Gretchen, Svetlana, Hillary and Sharon for making our lives easier at MIT.

I want to thank my closest friends and brilliant cousins in Turkey for always being there supporting me from the other side of the ocean. I am also thankful to my best friends in Boston, Erdem, Kartal, Onur, and Volkan, and especially to Cicek, Zizzy and Yonca for their warmth and long, fun, and intimate chats. I would also like to thank my close friend and house-mate, Tanseli, for sharing every stage of the graduate student experience with me and for spending countless hours listening to my complaints as well as my cheerful news.

I am indebted to Emrecan for his tireless encouragement about my work and very valuable friendship. His constant support was crucial for putting this work together. My special thanks go to him for sharing the ups and downs of the later periods of this thesis with me and for making me smile in even the toughest times.

I am also truly grateful to my precious aunt, Serpil Kahvecioglu, who taught me to treat life with a positive attitude and to always smile deeply towards people. I wish she could have seen the completion of this thesis.

Most importantly, my deepest thanks go to my parents, Nazmiye and Kemal Erel, who have always believed in me and who taught me to be self-confident in pursuing my dreams, and my one-and-only brother, Can. This work would not exist without their unconditional love, support, and encouragement. I feel extremely lucky to have such a wonderful and loving family. This thesis is dedicated to them.

October 2005
Cambridge, Massachusetts
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1 Chapter 1

The Effect of Bank Mergers on Loan Prices: Evidence from the U.S.

1.1 Introduction

During 1980-2003, total assets held by the 10 largest commercial banks in the U.S. increased from 22% to 46% of the industry assets while their deposits increased from 19% to 41% of the industry deposits (Pilloff (2004)). This fact is primarily because of the substantial increase in banking consolidation in the past decade.\(^1\) Hannan and Prager (1998) show that mega-mergers, which increase the concentration of the banking markets in the U.S., create unfavorable interest rates on deposits. In this chapter, I analyze the effect on borrowers and address the question of whether or not bank mergers benefit borrowers in the U.S. The reason for my choice of banking-firm mergers is the potential effect of the changes in loan prices or credit availability to small businesses on the real investment and the economy in general.

My goal, in particular, is to provide an understanding of the effect of bank mergers on loan prices, and to investigate whether or not value created by mergers is passed on to the borrowers through reductions in interest rates. For this purpose, I use a confidential loan-level data set from the Federal Reserve Board, which covers the characteristics of the new commercial and industrial (C&I) loan extensions of a stratified sample of U.S. commercial banks. Since the data include nearly all of the largest acquirers, my merger sample spans 62% of all the acquirer assets and 51% of all the target assets in the U.S. during 1990-2000.

The literature exploring the effect of banking consolidation on borrowers focuses

\(^1\)Figure 1.1, showing a part of the Bank of America’s family tree, is a good representative of the banking consolidation during the 1990s.
on two main issues. The first is the effect of bank mergers on credit availability to small businesses (e.g., Keeton (1996), Strahan and Weston (1998), Berger et al. (1998), Sapienza (2002), Degryse et al. (2005)); and the second one is the effect on loan prices (e.g., Akhavein et al. (1997), Sapienza (2002)). However, these papers analyzing the pricing effect of mergers use either aggregate bank-level data or data from other countries. To my knowledge, this is the first study to use loan-level data for C&I loans of U.S. banks in order to dynamically examine the effect of commercial bank mergers on loan prices.

I analyze acquiring banks before and after the merger. After carefully controlling for a number of loan characteristics, my findings show that they pass their efficiency gains on to the borrowers as more favorable interest rates on the new extensions of their C&I loans after the mergers. The average reduction in spreads on loans, within the three years after the merger, is both larger and also more persistent for the non-mega acquirers, with total gross assets less than $10 billion. Most importantly, the decline in spreads after the mergers is significant for small business loans, with loan sizes less than $1 million. This finding is especially important since, by showing that mergers result in better prices for small loans, I provide evidence of favorable effects of banking consolidation for small businesses. Contrary to what might be expected, bigger acquirers do not impose less favorable pricing terms for small businesses. Indeed, my findings show that small borrowers typically pay lower interest rates to banks that have expanded during the previous few years through mergers.

This chapter explains the after-merger reductions in spreads by some cost efficiencies reflected in loan spreads primarily because of the following results. First, the operating cost ratio of the acquiring bank after the merger is compared to the same ratio of the pro-forma bank (target plus acquirer before the merger). The reduction in spreads is found to be significantly greater for the acquirers with larger than median decline in their operating cost ratios than for the acquirers with smaller than median
decline in their operating cost ratios.

Second, my analyses differentiate different types of mergers based on the geographical market overlap between the acquirer and the target before the merger, and the results are consistent with what theory would imply regarding the different effects of in-market and out-of-market mergers on loan prices. In-market mergers, where the acquirer and the target were operating in at least one common banking market before the merger, could create opportunities for exercising market power by increasing the concentration of these banking markets. However, when compared to the out-of-market mergers, in-market mergers also offer much more potential for cost savings through elimination of the least efficient of the overlapping branches or consolidation of the operations. Consistent with the predictions of the theories on potential efficiency and market power effects of the in-market mergers, the reduction in spreads is the most significant if the acquirer and the target have some overlap of markets before the merger. However, this result is true only if the overlap is not so extensive as to significantly increase the market power of the acquirer, in which case market power effect outweighs and spreads on loans significantly increase after the mergers.

For the out-of-market acquirers, with no geographical market overlap with the target before the merger, the potential for efficiency gains through consolidating operations or closing the least efficient of the overlapping branches does not exist. However, the consolidated bank could enjoy some other efficiencies, such as scale efficiencies or risk diversification. Moreover, acquirers could have a very different strategy after the out-of-market mergers: in the new markets they enter, they could try to gain more market share by offering lower rates than the target and the rival banks used to offer before the merger. My analyses show that the reduction in loan prices is on average lower and statistically less significant for out-of-market mergers than for in-market mergers.

In order to test for the motives for the strategic price cut of the out-of-market
acquirers, I add one more layer to my tests and incorporate the structure of the target’s markets into my regressions. I check whether the change in spreads after the market extension mergers of the large acquirers is affected by whether targets’ markets were dominated by large or small banks before the merger. Only if the new markets entered through the merger were dominated by larger banks, are acquirers found to be significantly reducing spreads on large loans starting within the first year after the merger. This occurs because in a market dominated by small banks, a big acquirer would already be more efficient and therefore charging lower prices on a given loan than the prices of the existing small-sized competitors.

I further examine whether my results are driven by any after-merger change in the quality of the acquirers’ loan portfolios. First, I show that there is no significant change in the extent of nonperforming loans of the acquirer after the merger. Second, I explore the possibility of shifts in the volume of loans with certain characteristics within the portfolio of the acquirer after the merger. The results show either no change or change in the direction that would, in fact, bias my results in the opposite direction. Both checks provide more support for the conclusions of this chapter.

In order to alleviate concerns regarding the endogeneity of the timing of the mergers in my sample, I used an exogenous instrument, the variation in banking deregulation across states, for the dates of the mergers. Banking literature recognizes the removal of intrastate and interstate banking restrictions as the main reason for the huge increase in the number of mergers in the 1990s. Therefore, in order to analyze the indirect effect of the deregulation on loan spreads, I also ran my basic tests at the banking market level by using the dates of intrastate deregulation instead of the dates of the in-market mergers. After controlling for the increase in market competition due to deregulation, my regressions result in both statistically and economically significant decline in spreads starting within the third year after the deregulation.

Lastly, in order to complement the chapter’s findings related to loan prices, I also
analyzed the effect of bank mergers on small business lending of the merging banks. For that purpose, bank-level data on the aggregate quantities of small business lending are used. However, the data are available only after 1993, and are annual. Therefore, the tests exploring the effect of bank mergers on credit availability are not in as much detail as the tests on loan spreads, and I acknowledge the possibility that very risky small borrowers of the target might be credit-rationed after the merger. However, a simple mean difference test shows that, on average, the ratio of small business lending to total assets of the acquirer after the merger is not significantly different than the same ratio of the pro-forma bank (target plus acquirer) before the merger.

Credit availability to small businesses from large banks could have been increasing, especially since the late 1990s, due to some new technologies applied to commercial bank lending, such as credit scoring models, which enable small businesses to provide some “hard” information to the banks. This study, therefore, complements Petersen and Rajan (2002), which shows that the physical distance between small businesses and their banks has been increasing, in providing evidence for the possible increase in small borrowers in large banks’ loan portfolios.

The remainder of this chapter is structured as follows. The rest of this section discusses possible effects of banking consolidation on loan prices and credit availability, states the main hypotheses to be tested in this study, and reviews the related literature. Section 1.2 describes the data and my sample. Section 1.3 presents the statistical methodology, defines the variables, and shows the main results as well as results for some subsamples of mergers and loans. In Section 1.4, the market overlap between the acquirer and the targets, and also the competitiveness of the targets’ markets, are incorporated into the analyses. Section 1.5 provides additional robustness checks for the efficiency gains. Section 1.6 uses the variation in the dates of banking deregulation as an exogenous instrument for the timing of the mergers. Section 1.7 briefly explores the effect of mergers on credit availability to small businesses.
Section 1.8 discusses the findings of this chapter and presents its conclusions.

1.1.1 Potential Effects of Mergers on Loan Prices

Effects of bank mergers on loan prices are ex-ante uncertain. For instance, mergers may increase the efficiency through synergy gains and growth or through re-optimization of the loan portfolios and risk diversification. The evidence on whether these efficiency gains are reflected in combined stock returns of the merging banks around the merger announcement is mixed. However, insignificant results could be due to some information that the stock price incorporates other than the efficiencies, such as the negative signaling of overvalued stock (Houston and Ryngaert (1997)), or simply because these mergers are largely expected (Houston et al. (2001)). Houston et al. (2001) show that, unlike the 1980s, combined stock returns to the bidders and targets are higher in 1990s, and the cost savings due to increased frequency of “in-market” mergers constituted the primary source of these bank-merger gains. On the other hand, according to Calomiris and Karceski (1999), insignificant stock returns to the combined bank could be due to the fact that, in a competitive market, significant portion of the efficiency gains are passed on the bank customers; therefore, transaction costs or interest rate spreads might be more useful measures of efficiency gains than stock prices.

Holding characteristics of the loans constant, if efficiency gains are passed on to the borrowers, interest rates would be expected to decline. However, if merging banks have significant overlap in their markets of operation, the merger could increase the

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2See Berger et al. (1999) for a detailed description of different types of efficiency consequences for banks. The empirical evidence on post-merger accounting performance is mixed. (See, Berger and Humphrey (1992), Cornett and Tehranian (1992), Toevs (1992), Pilloff (1996), Akhavain et al. (1997), and Berger (1997), etc.)


4See also Penas and Unal (2004), analyzing the commercial bank mergers between 1991 and 1998, show that risk- and maturity- adjusted returns of the bondholders of both the acquirer and the target around the merger announcement month are significantly positive and these results are not due to wealth transfers from shareholders to bondholders since equity holders also realize positive returns.
concentration in these banking markets and, consequently, the market power of the consolidated bank.\(^5\) If the acquirer chooses to exercise market power after the merger, interest rates on loans would instead be expected to increase. Existing empirical literature on concentration in banking markets illustrates this positive relationship between market concentration and higher prices on loan contracts (Hannan (1991)) and on deposits (Berger and Hannan (1989)). Therefore, the net effect on loan prices would depend on whether these market power or efficiency effects dominate (Williamson (1968, 1975)).

Focarelli and Panetta (2003) argue that there might be an asymmetry in how fast these effects occur. By analyzing the changes in deposit rates after the in-market mergers in Italy, they provide evidence that the gestation period for the efficiency gains to be realized could be up to three years after the merger. Due to data limitations, the literature on the pricing effect of mergers in the U.S. is limited.\(^6\) There exists some empirical evidence on the unfavorable results of increased market concentration due to big bank mergers on deposit rates (Hannan and Prager (1998)), on personal loan rates in 10 U.S. cities (Kahn et al. (2005)), and on real-estate loan rates (Garmaise and Moskowitz (2004)). On the other hand, Drucker (2005) shows that commercial banking mergers among the 50 largest banks do not result in significant changes in the pricing of their large syndicated loan contracts. Drucker (2005) mainly concentrates on the effect of mergers between commercial banks and investment banks during 1997-2003 by using a limited sample of mega banks and their

\(^5\)Rhoades (2000) documents that mergers are the main source of changes in banking structure and competition between 1990-1998 since newly chartered banks and bank failures are considerably smaller in number. Therefore, this study concentrates only on the mergers and their effect on banking concentration.

\(^6\)On the theory side, the only theory paper on this topic, to my knowledge, is by Park and Pennacchi (2005). They concentrate on market extension mergers by large multi-market banks into a new market of smaller bank competitors. They argue that these mergers, given that they do not change the market concentration, increase the retail loan competition (benefiting borrowers), but reduce the retail deposit competition (harming depositors). The argument is based on two main assumptions: the first is that large banks set interest rates uniformly across markets (Radecki (1998)) and the second is that they have access to cheap wholesale deposits.
large syndicated loans, and therefore is different from this study. Sapienza (2002) uses a loan-level data set for Italian banks, and concludes that in-market mergers involving relatively small targets result in lower interest rates charged on loans. This chapter is similar to Sapienza (2002) in exploring the effect of mergers on loan prices by using loan-level data, but my analysis focuses on U.S. data instead of the Italian data. The main contributions of this study are as follows. Consistent with the hypothesis that the after-merger decline in spreads is due to efficiencies created by mergers rather than any change in the quality of the borrowers or in the competitiveness of the markets, this study shows that the reduction in spreads is both statistically and economically more significant for the subsample of mergers with larger than median after-merger decline in their operating costs than the subsample of mergers with smaller than median operating cost decline. Moreover, my analyses also incorporate the structure of the targets’ markets (whether they were dominated by large vs. small banks before the merger). Lastly, unlike Sapienza (2002), this study also addresses the issue of the endogeneity of the timing of the mergers, by using the dates of U.S. intrastate banking deregulation as an instrument.

1.1.2 Potential Effects of Mergers on Small Business Lending

Since small businesses are less transparent, there exists a large asymmetry of information between these firms and potential lenders. However, banks can reduce a possible credit rationing problem (Stiglitz and Weiss (1981)) by forming “relationships” through which small businesses can find access to capital, but not always with favorable prices (Petersen and Rajan (1994)). While small banks specialize in these more soft-information-based “relationship loans” to smaller and more opaque borrowers, large banks mostly make “hard” (quantitative) information-based “transaction loans” to larger and more transparent borrowers. Some possible explanations for the

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7 See Boot (2000) for its literature review of the relationship lending literature and also Berger and Udell (2002) for detailed explanations of different types of lending.
disadvantage of large banks in relationship lending could be Williamson-type organizational diseconomies of giving both types of loans (Berger, Demsetz, and Strahan (1999)), or the hierarchical structures of the large banks, where quantitative, easily transferable information about potential borrowers is more valuable for the loan officer of lower rank (Stein (2002)). However, it has also been empirically shown that large banks, when they make small business loans, require lower interest rates and less collateral for these loans (Berger and Udell (1996)).

All these theories imply that after the consolidation, large acquirers would significantly drop small “relationship loans” of the smaller-sized targets. Although Strahan and Weston (1998) find that there is no significant change in lending to small businesses, Keeton (1996), Peek and Rosengren (1996), Berger et al. (1998) and Sapienza (2002) give evidence of a decline in the amount of small business lending after the large bank mergers. However, in the late 1990s, improvements in information technology and adoption of credit scoring models for small business lending could have enabled large banks to acquire more “hard” information on small loans. Small business credit scoring is a data processing technology about the firm and the credit history of its owner using statistical methods, and it creates opportunities for non-transparent small firms to borrow from large banks.  

1.2 Data and Sample Description

1.2.1 Data

The primary data source for this chapter is the Federal Reserve Board’s Survey of Terms of Business Lending (STBL). STBL provides confidential data on the charac-

\(^8\) See Udell (1989), Nakamura (1993), Berger and Udell (1995), Cole, Goldberg, and White (1999), and Berger et al. (2005b) for more discussion and empirical evidence on differences in lending between large and small banks.

\(^9\) See Hand and Henley (1997) for a review of the statistical methods used in credit scoring and Berger et al. (2005a), Berger and DeYoung (2005), and DeYoung et al. (2005) for the effects of its application in the banking industry.
teristics of individual commercial and industrial (C&I) loan extensions of a stratified sample of roughly 300 U.S. commercial banks and 50 branches of foreign banks. It covers all C&I loans (new loans, takedowns under revolving credit agreements, and renewals) of a given bank with a face value of at least $1000, disbursed within the first business week of February, May, August, and November. To my knowledge, STBL is the only loan-level data source covering C&I loans of different sizes and characteristics extended by a stratified sample of U.S. commercial banks.10

The flow nature of the data, covering new loans and renewals, is ideal for my analysis since the effects of the merger would be reflected mostly in the new loans, rather than the entire portfolio of existing loans. The information on loan characteristics is very detailed, including the stated rate of interest, loan size, total size of the commitment (line of credit) under which the loan was extended, maturity, frequency of payments, whether the loan is secured or not, whether the loan is fixed or floating-rate, etc. One limitation of the data is that it does not provide information on characteristics of borrowing firms. Following the prior literature (see, for instance, Berger et al. (1998)), my analyses will proxy for the size of the borrower by the maximum of the size of the loan and the total amount of commitment under which the loan was drawn.

The survey covers nearly all of the large banks in the U.S. and a sample of medium-sized and small banks. If and when a bank decides not to report any more, another bank with similar characteristics is chosen to replace it. The Federal Reserve System uses the survey to measure the average cost of business borrowing in the U.S. economy. Therefore, concerns about reporting biases and sample selection issues are alleviated by the fact that this survey is not used for regulation purposes.

I matched the STBL to three other data sources. First, I use the quarterly Reports

10 Loan Pricing Corporation’s Deal Scan provides loan-level information as well. However, for this chapter’s purpose, Deal Scan would not be an appropriate data source since it includes only the large, syndicated loans of the largest U.S. banks. Besides, the share of each agent-bank within the syndication is blank in a considerable portion of the data.
of Condition and Income (Call Reports), which provide aggregate bank-level income statement and balance sheet data. Small business loan data are from June Call Reports. Second, the Federal Deposit Insurance Corporation’s branch-level Summary of Deposits data are used to determine which local banking markets are served by the sample banks. The last data source is the National Information Center (NIC) Data File, which provides information on the merging banks and the dates of the mergers.

1.2.2 Sample Selection and Descriptive Statistics

Table 1.1 documents descriptive statistics of STBL banks between 1987 and 2003. The sum of total assets of all surveyed banks has a mean of about $2.7 trillion over 68 quarters, which corresponds, on average, to 53% of all banking assets. The median bank in the survey has gross total assets of about $1.2 billion. However, the mean value of gross total assets is $9.8 billion, showing that the survey is biased towards larger banks. The net return on assets has a mean and median of 1%, while the non-performing loans ratio is, on average, 2%. Panels B and C of the same table describe respective descriptive characteristics of the acquirers and targets, as of one quarter before the merger. Compared to the median bank in the sample, the median acquirer is larger (with $6.1 billion of gross total assets) and the median target is smaller (with about $184 million of gross total assets). Net return on assets for the median acquirer is 8.2%, while it is 0.9% for the median target.

The merger sample of this chapter covers the period between 1990 and 2000. I concentrate on the 1990s because of the large increase in the number of bank mergers in this decade. This increase is due to the removal of intrastate and interstate branching restrictions on banks in the 1980s and early 1990s, officially finalized by the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994.11 Some

11See, for instance, Berger, Kashyap, and Scalise (1995), Jayaratne and Strahan (1998), Berger, Demsetz, and Strahan (1999), and Kroszner and Strahan (1999) for more information on banking deregulation, its effect on bank mergers, and exact dates for each state. See also Andrade, Mitchell, and Stafford (2001) for the argument that deregulation is the dominant factor in merger
researchers suggest that it might take up to three years for the consolidating firms to fully realize efficiency gains (Berger et al. (1995), Calomiris and Karcseki (2000), Focarelli and Panetta (2003)). To address this issue, loan-level observations of this study span 68 quarters between 1987 and 2003, which include a three-year period before the first and after the last merger in my sample. STBL covers in total about 2.2 million bank-loan-quarter observations for this time period.

Table 1.2 presents summary statistics of the loan-level observations. The mean face value of all loans is $727,143 while the mean value of the total commitment amount is about $5.3 million. Average spread (effective annual interest rate, net of the treasury rate of the same duration as the loan) is 4.25%, but it declines to 2.75% when only large loans are considered. Weighted by the loan size (which is equal to the total commitment amount if the loan is drawn under commitment and to the face value of the loan otherwise), 82% of all loans is under commitment, and this ratio increases to 96% for large loans of size above $25 million. On average, 73% of the value of all loans is secured by some type of collateral while 75% is floating-rate.

In this study, I call any consolidation of two non-failing commercial banks a “merger” if the charter of the target disappears and only the acquirer survives. After the banking deregulation, one common type of merger is the consolidation of several branches of, in fact, the same bank, which had to operate in different states with separate charters because of the branching restrictions of the time period. These “within family” mergers are excluded from my “merger” sample. Between 1990 and 2000, there were 2,274 commercial bank “mergers” in the U.S. For my empirical analyses, more than one merger of a given acquirer within the same quarter is used as a single data-point. This reduces the number of mergers to 1,857 “merger-quarters,” defined as quarters in which the acquirer merges with at least one target. STBL and acquisition activity after the 1980s.

12 This chapter analyzes commercial banks rather than bank holding companies (BHCs) mainly because decisions on the characteristics of loans are mostly made at the bank level rather than the BHC level.
covers 263 of these “merger-quarters,” corresponding to 350 mergers by 121 banks.\textsuperscript{13} Since the survey includes nearly all of the large banks, these 263 merger-quarters represent a very significant portion of the mergers in the U.S.: 62% of all acquirers’ assets and 51% of all targets’ assets.

1.3 Dynamic Effect of Mergers on Loan Prices

This section will introduce the methodology of the study and show the basic results. It will explore how the interest rates charged on the C&I loan flow of an acquirer change after the merger, after controlling for the size and other characteristics of these loans.

1.3.1 Basic Test and Variable Definitions

To analyze the effect of mergers on loan prices, I estimate the following before-after regression in the event time with a six year window around the merger:

\[
Spread_{i,k,t} = \alpha + \beta_1 AftMrgrOne_{k,t} + \beta_2 AftMrgrTwo_{k,t} + \beta_3 AftMrgrThree_{k,t} \\
+ \beta_4 LoanSize_{i,k,t} + \beta_5 MrgrSize_{k,t} + \lambda_1 X_{i,k,t} + \lambda_2 Y_{k,t-1} + \delta_t + f_k + \varepsilon_{i,k,t}
\]

The dependent variable, \(Spread\), is the effective annual interest rate, which is the ratio of the realized yield from compound interest for one year to the amount of the loan, on loan of bank in quarter minus the Treasury rate of equal duration as the loan.\textsuperscript{14} For the fixed-rate loans, the Treasury rate of equal duration as the loan is

\textsuperscript{13}Small acquirers, which have gross total assets of less than $100 million, were deleted from the sample since they both had very short time series with many gaps, and loans that they reported per quarter were very small in number (only 1 in some quarters) and noisy. Only 0.7% of all STBL loan-level observations and 4 merger-quarters are lost in this way; and including these observations both statistically and economically does not alter the loan-level coefficients reported, but could distort the bank-level regression results.

\textsuperscript{14}The data do not include fees charged on loans, but this could only bias my results if fees depend on certain characteristics of the borrowers, and if this dependence changes after the merger, which is very unlikely. Generally, large banks have certain policies on fee structure based on the size of the loan, and these policies do not systematically vary by borrower characteristics.
subtracted from the effective interest rate. For floating-rate loans, the appropriate
duration is the next re-pricing interval, but the data for this variable are only available
after 1997. However, for most of the floating-rate loans reported after 1997, the
expected re-pricing interval is up to a month. Therefore, in order to normalize the
spreads for the floating-rate loans, I used either the one-month Treasury rate or (if the
maturity is less than a month) the Treasury rate corresponding to the maturity of the
loan. Alternative methods of calculating the spread are also checked, such as using a
one-day rate instead of the one-month rate to normalize floating-rate loans or using
prime rate instead of the Treasury rates in calculating spreads. As another robustness
check, Treasury rates are also replaced by LIBOR (London Inter Bank Offer Rate)
and swap rates of equal duration since those rates could reflect the funding costs of
the banks better than the Treasury rates, especially in the later periods of the data.\textsuperscript{15}
The average spread per quarter for all the banks in the data other than the acquiring
banks was also checked to be included as a control. The results are both economically
and statistically unchanged.

I use three after-merger dummy variables which span three years before and after
the merger. $AftMrgrOne$, $AftMrgrTwo$, and $AftMrgrThree$ are dummy variables
equal to zero for twelve quarters before and after the merger, except that $AftMrgrOne$
is equal to one for the first four quarters after the merger, $AftMrgrTwo$ is equal to
one for the fifth to eighth quarters after the merger, and $AftMrgrThree$ is equal to
one for the ninth to twelfth quarters after the merger.

Each regression includes $LoanSize$, the natural logarithm of the size of the loan.
Since the data set does not provide information on the firm characteristics of the
borrowers, regressions will use loan size as a proxy for the size of the borrowing firms.

\textsuperscript{15}Treasury data used are one-, three-, six-month constant maturity Treasury bill rates, and one-,
two-, three-, five-, seven-, ten-, twenty-year Treasury notes. The rates for maturities other than
these are calculated by simple interpolation and extrapolation. One-, three-, and six-month LIBOR
(London Inter Bank Offer Rate), in addition to one-, two-, three-, five-, seven-, ten-, and twenty-year
swap rates, are used as for the robustness check.

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Loan size is equal to the total commitment (line of credit) amount if the loan is drawn under commitment and to the face amount of the loan otherwise. That is because total commitment amount better proxies the size of the borrower than the face value of the loan. Loan size is, in fact, endogenous since it could potentially be affected by mergers, and one might actually think that including loan size over-controls for changes due to the merger. *MrgrSize* is equal to the natural logarithm of the total size of the target as of one quarter before the merger and is used to control for the size of the merger. For merger-quarters in which an acquirer merges with more than one target, merger size corresponds to the sum of the gross total assets of all these targets.

In addition to these main variables, regressions include some market-related as well as firm- and loan-specific controls. Note that the basic tests include only the level of the merger size and the market-related variables as controls instead of their interactions with the after-merger dummy variables. That is because following sections of the chapter will include extensive analyses of these interactions. *StateDummy* is a dummy variable equal to 1 if the target and the acquirer were in the same state before the merger. This variable is included because, as already explained, elimination of intrastate restrictions was the most important reason for the increasing number of mergers in the 1990s.\(^{16}\) *MrktHHI* is the natural logarithm of the average Hirfindahl-Hirschman Index of the markets which the acquirer serves.\(^ {17}\) I also included a set of loan characteristics \((X_{i,k,t})\) in addition to the loan size to control for their additional effect on interest rates. But, due to the endogeneity of these characteristics, including them in the regressions might also over-control for changes after the merger. These

\(^{16}\)All merger-quarters, which have both in-state and out-of state mergers of a given acquirer in a given quarter, are dropped; however, these types of merger-quarters were very few in number. I also checked to include a dummy variable equal to 1 if the state in which the acquirer operates was deregulated or not (both for intra and inter-state deregulation). The results were not altered.

\(^{17}\)The Hirfindahl-Hirschman Index is calculated as the sum of the squares of the deposit market shares of all banks in a given market. It is based on deposits rather than loans, because there is no market-level data for bank loans.
characteristics include $DummyCommit$, which is equal to one if the loan is drawn under a formal or informal commitment, and zero otherwise. $DummyFixed$ is equal to one if the loan is a fixed-rate loan, and is equal to zero if it is a floating-rate loan. $DummySecured$ is equal to one if the loan is secured by collateral of any kind, and zero otherwise. Moreover, each regression includes a set of bank-specific controls measured as of $t-1$, $Y_{k,t-1}$. These controls include the natural logarithm of the gross total assets of the acquirer ($AcquirerSize$) and its nonperforming loans ratio ($NonperformRatio$), which is calculated as the sum of loans over 90 days late and loans not accruing over total loans. Each regression includes bank fixed-effects ($f_k$) in order to use the bank before the merger as a control for itself after the merger. Moreover, I account for serial correlation by allowing for clustering of the error term at the bank level. Lastly, $d_t$ corresponds to the 67 quarter dummies.

1.3.2 Main Results

Table 1.3 reports results of the basic regressions for the whole sample of loans and all types of mergers. The first column shows the very basic regression results, including only the lagged size of the acquirer in addition to three after-merger dummies, and the second column adds the loan size, which proxies the size of the borrower. The favorable effect on loan prices starts within the first year after the merger, but becomes statistically much more significant in the second year. The coefficient on $AftrMrgryOne$ is equal to -7 basis points, and adding other controls does not alter this result except that in the regressions including $StateDummy$ it decreases to only -6 basis points. The second-year dummy has a coefficient of -11 basis points without controlling the loan size and -7 basis points when we control for the loan size, and is always statistically

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18The differences in the total number of observations between columns are due to lack of data for a few observations of some variables. For instance, for a couple of the targets, gross total assets corresponding to specific dates could not be found. Besides, as explained before, the total number of observations declined by a few observations in regressions including $StateDummy$ because of some dropped merger-quarters.
significant at the 1% level. As expected, LoanSize, which proxies the size of the borrower, has the expected negative and statistically significant coefficient.

Regressions in columns three and four include the total assets of the target, which is the proxy for the size of the merger (MrgrSize), and the results are unaltered. Besides, after the merger, gross total assets of the acquirer already include the size of the target; therefore, when MrgrSize is used in addition to the size of the acquirer (AcquirerSize), its marginal effect as a control is insignificant. In the rest of the chapter the regressions will only include the size of the acquirer before and after the merger. The significant reduction in spreads is robust to including StateDummy and MrktHHI as well.

The coefficients in front of the dummies reflecting different characteristics of the loans are consistent with the existing empirical literature. Loans secured by collateral of any kind have higher spreads than unsecured loans (Berger and Udell (1990)), while floating-rate loans have higher spreads than the fixed-rate loans. Loans under commitment have lower spreads compared to loans not under commitment.

Although Focarelli and Panetta (2003) mention about three years of gestation period for efficiency gains to be fully realized, my analysis shows that the average decline in the spreads starts within the first year after the merger and has its peak between the fifth and eighth quarters after the merger. When the first year effect is decomposed into quarters, regressions using quarter by quarter after merger dummies demonstrate that significant negative change is coming in the third and fourth quarters. Similarly, Sapienza (2002) finds that, in Italy, the efficiency gains create favorable loan prices about six months after the mergers.

\footnote{However, I will always check whether or not including target size in addition to the acquirer size alters the results}

\footnote{Since DummyCommit is highly correlated with SizeLoan, I excluded loan size from the regression including the commitment dummy. The significantly negative coefficient of DummyCommit is also robust to including the natural logarithm of the face value of each loan as a control.}

\footnote{Although unlikely, the significance of the t-statistics in the loan-level regressions might be a consequence of the large cross-sectional variation could have blown up t-statistics, even though standard errors in all regressions are corrected for clustering of observations at the bank level.}

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1.3.3 Main Results with "After-Last-Merger" Dummies

Surveyed banks include many large acquirers, which may have many mergers within a short time. In my sample, 39 of the 263 merger-quarters are the second merger quarter in a row, and 98 are merger-quarters of the same bank which had at least one merger within the past year. As a consequence, after-merger dummies could often overlap in taking the value of one within their corresponding years after the merger. This possibility might reduce the variation in my sample and bias the economic significance of my estimates downwards. In addition, one might believe that the last merger in a succession of mergers might have the biggest effect. In order to be able to compare the economic significance of coefficients, I created a set of new "After-Last-Merger Dummies," by modifying the variables $AftrMrgrOne - AftrMrgrThree$ such that, in a given quarter, the corresponding year's after-merger dummy is switched on for only the very last merger, ignoring all the other mergers even if they occurred within the last three years. For instance, $AftrMrgrTwo$ is equal to 1 in the fifth to eighth quarters after the merger only if those 1's do not coincide with the first four quarters of another merger of the same bank; and $AftrMrgrThree$ is equal to 1 in the ninth to twelfth quarters after the merger only if those 1's do not coincide with the first eight quarters of another merger of the same bank. The first two columns of Table 1.4 compare the coefficients of the new "After-Last-Merger Dummies" to the ones of the original after-merger dummies. The difference in the economic significance of the coefficients is noticeable. The average decline in spread within both the first and second years after the merger is 12 basis points if after-last-merger dummies are used, while the same decline is only 7 basis points if the original overlapping after-merger dummies are used.

In order to address this concern, the same set of regressions was run by using bank-quarter-level observations as well. For that purpose, the mean of the interest rates charged on loans as well as their sizes at the bank-quarter level were used, after collapsing the loan-level data by bank, quarter, and some characteristics of these loans. The results were both economically and statistically unaltered.
1.3.4 Results for Subsamples Based on Merger Size

In addition to using only the last merger in a series for a given acquirer, this section explores the larger- or smaller-than-median mergers of the same acquirer by using the median target size ($\text{MrgnrSize}$, as already defined) of each acquirer over the sample period. The last two columns of Table 1.4 show the results of the regressions using the following two subsamples: \textbf{“Larger-than-Median Mergers”} and \textbf{“Smaller-than Median Mergers”} of a given acquirer. The number of observations declines by at least 110,000, meaning that concentrating only on the larger- or the smaller-than-median mergers of the same acquirer does not eliminate mergers totally from in between the successive mergers. After the larger-than-median mergers of a given acquirer, the decline in spreads is statistically significant only within the second year after the merger. However, smaller-than-median mergers result in reductions in spreads starting within the first year, and this decline is also statistically significant within the second and third years after the merger. By using \textbf{“After-Merger Dummies”} (\textbf{“After-Last-Merger Dummies”}), my analysis shows that smaller-than-median mergers of a given acquirer result in a decline of, on average, 8 (11), 8 (12), and 8 (12) basis points on C&I loan spreads within, respectively, the first, second, and third years after the merger.

1.3.5 Results for Subsamples Based on Loan Size

Estimation using a whole sample of loans is less than ideal; a very large loan drawn under a large commitment should be analyzed separately from a very small loan of face-value or commitment size less than $100,000. This is true because loan size proxies for the borrowing-firm size, and commitments to really big companies should be differentiated from loans to small businesses since they are made based on different lending technologies (see section 2.1 for the theories of different lending technologies). Moreover, given that acquirers generally buy targets of much smaller sizes, new ad-
ditions to the acquirer's loan portfolio would most likely be the smaller loans of the
target or the potential new customers of smaller firms in targets’ markets. Furthermore,
as observed above, the spreads on large commitments to the existing borrowers
of the acquirer are already much lower than on smaller sized loans. Therefore, any
gains due to diversification, scale, or scope economies are expected to be reflected
more with smaller borrowers.

Table 1.5 presents results for subsamples based on the loan size, which is equal
to the total commitment amount if the loan is drawn under commitment, and to the
face value of the loan, if otherwise.\textsuperscript{22} Spreads on small loans with size less than $1
million decrease, on average, by 15 basis points (b.p.) within the first year, and 14
b.p. within the second year after the merger. If “After-Last-Merger Dummies” are
used instead of the original overlapping after-merger dummies as the right-hand-side
(RHS) variables, the first and second year declines in the spreads become 23 and 20
b.p., respectively. All these coefficients are significant at the 1% level. On the other
hand, the change in the spreads on large loans (of size larger than $1 million) is not
statistically different from zero. The largest decline in spreads within the first and
second years after the merger, using “After-Merger Dummies” (“After-Last-Merger
Dummies”), is for the smallest borrowers. It amounts to 23 and 16 (30 and 23) basis
points for loans of size less than $100,000, and 21 and 16 (28 and 23) basis points for
loans of size less than $250,000. All coefficients are significant at the 1% level.

The rest of the chapter will report the results of the regressions using "After-
Merger-Dummies," even though they have economically less significant coefficients
than "After-Last-Merger Dummies," except for times when both are reported. That
is because "After-Last-Merger Dummies" concentrate on only the last merger in a
succession of mergers while "After-Merger-Dummies" include all of the mergers of an

\textsuperscript{22}Existing literature generally defines Loan\textsuperscript{Size} of less than $1 million as the small loans; however,
some papers use $250,000 or $100,000 as the cut-off dollar amounts for small loans. Therefore,
regression results for different subsamples of small loans will be reported.
1.3.6 Results for Subsamples Based on Other Loan Characteristics

Table 1.6 shows the results of the regressions for two different subsamples based on loan characteristics. In Panel A, our original set of regressions were run first including only the loans drawn under commitment ("Loans under Commitment") and then for loans that are not under commitment ("Loans not under Commitment"). Although loans not under commitment are much fewer in number compared to the loans under commitment, the decline in their spreads is both economically and statistically more significant. This is probably because nearly all of the non-commitment loans are small loans, of loan size less than $1 million, and mostly less than $250,000. However, the difference in the statistical significance of the two subsamples for the first year could be a data issue; for the loans under commitment, the initiation dates of the commitments were not recorded for the time period used by the analysis. However, most of the loan commitments are up to a year. Therefore, the lack of initiation date for the commitment is not a problem for the second year after the merger.

Panel B includes the same set of regressions for subsamples based on whether the loan is secured or not ("Loans Secured by Collateral" vs. "Loans not Secured by Collateral"). Panel B shows that secured loans are driving the main results, perhaps because unsecured loans are generally larger in size, and fewer in number. When the unsecured loans are excluded from the sample, the decline in spreads within the third year after the merger is statistically significant and equal to 11 and 10 basis points for the all-loans sample and small loans, respectively.

23 Same subsample analyses were also made based on some other characteristics of loans, such as whether the loan is a fixed vs. floating-rate loan, demand vs. non-demand loan, etc. The results are not reported because there was no interesting difference between these subsamples.
1.3.7 Potential Changes in Loan Portfolios after the Mergers

One alternative explanation for the main results presented in section 3.2. is a possible change in the riskiness of the acquirer’s loan portfolio after the merger. Since STBL data do not link loans and the firm characteristics of the borrowers, it is not possible to control for possible changes in the characteristics of the loan portfolios after the merger, nor can we track existing borrowers of the acquirer after the merger. In terms of control, loan or commitment size is used as a proxy for the borrower size in all the regressions. Additionally, since targets are, on average, much smaller and riskier than their acquirers, the additions to the acquirer’s portfolio after the merger are expected to be relatively smaller and riskier borrowers; hence, if kept in the portfolio, they are expected to increase the riskiness rather than decrease it.

However, using aggregate data, we can check whether there was any risk-shifting in the loan portfolios of the acquirer after the merger. Changes in the nonperforming loans ratio are used as a proxy for changes in the riskiness of the portfolio. If the alternative explanation were correct, one would expect the nonperforming loans ratio of the acquirer to decline after the merger. Following prior literature, the nonperforming loans ratio is calculated as the ratio of loans more than 90 days late, plus loans not accruing, to the total loans. The results of regressing nonperforming loans ratio on the three-year-after-merger dummies show that there is no statistically significant change in the nonperforming loans ratio of the acquirer after the merger, when compared to the same ratio before the merger. (The results are not reported since the coefficients for all three years after the merger were both economically and statistically not different from zero.) A possible longer-run change is checked by using five-year-after-merger dummies, as well and the conclusions remain unaltered.

The literature emphasizes that loan characteristics could also affect the interest rates charged on loans. (See, for instance, Berger and Udell (1990), arguing that collateral is most often associated with higher-risk loans, and consequently with
higher interest rates.) To check this possibility, loan-level data was used to determine whether or not the volume of certain types of loans within the acquirer's portfolio changed after the merger. Table 1.7 presents the results for ratios based on three main characteristics within the portfolio of all loans as well as the subsample of small loans. The main results of this chapter could be similar if, given loan size, the volume of secured loans, or fixed-rate loans, or loans under commitment were to increase in banks' portfolios after the merger. (See the signs of the coefficients of these loan characteristics in Table 1.3.) The dependent variable in Panel A is the ratio of secured loans in banks' portfolios, which is the total volume of loans secured by any type of collateral over the total loans of a given bank in a given quarter. The only significant result is the positive coefficient in front of the first-year after-merger dummy. As shown in Table 1.3, loans secured by collateral are more risky, and consequently have higher spreads given their size; therefore this positive coefficient would not drive the results. On the contrary, it would bias first-year results in the opposite direction.

Panels B and C present the results of the similar analyses for changes in the volume of loans under commitment and the volume of floating-rate loans within the acquirer's portfolio after the merger. No coefficient of interest turned out to be significant in Panel B. The significantly positive first-year coefficient in Panel C (following the same line of thought as for ratio of secured-loans) was interpreted as evidence that would in fact bias first-year coefficients of the main regressions in the opposite direction.

Although only one subsample of small loans is reported, changes in all these ratios were analyzed within the subsample of large loans in addition to different subsamples of small loans, along with changes in the natural logarithm of the face value or loan

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24 Table 1.7 presents only the results based on three main characteristics of loans. Changes in ratios based on different sizes and duration of loans were also checked, but not reported to save space. Moreover, all the regressions were run by excluding very short-term or very long-term loans as well as excluding demand loans with no stated maturity. All the results are robust to these checks.

25 As a side point, it should be noted that ratio of secured loans increases in the portfolio of new loan extensions within the first year after the merger. A possible explanation could be that, on average, more collateral is asked for in the restructuring phase after the merger because the acquirer might have some information disadvantage regarding the potential customers of the target.
size within different size categories post merger. The regression analyses show no
significant change within the first two years. Changes in the number of certain types
of loans in addition to the volume of them within the portfolio were also analyzed.
All these robustness checks support that the reduction in the spread is not driven by
changes in the types of loans that the banks make.

1.4 Market Overlap and Target’s Market Structure

The following two sections will differentiate types of mergers, based on the geograph-
ical market overlap between the acquirer and the target as well as the structure of
the target’s markets.

1.4.1 In-Market vs. Out-of-Market Mergers

In-market mergers are defined as mergers of two banks which were serving at least
one common banking market before the merger. Out-of-market mergers, on the other
hand, are market-extension mergers, where target and acquirer did not have any
market overlap. In-market mergers produce much more potential for both exercising
market power and creating efficiency gains. First, compared to a merger of no market
overlap, the concentration of the after-merger banking market, hence the market
power of the acquirer is more likely to increase. Second, the consolidated bank would
have more offices to consolidate, more overlapping operations from which to choose
the most efficient, more common local expertise to share, and consequently more
synergy to create.\textsuperscript{26}

\textsuperscript{26}See DeLong (1998) showing that mergers that increase geographical focus increase value. Hous-
ton and Ryngaert (1997) and Houston et al. (2001) also show that stock returns to the combined
bank are positively correlated with the geographical overlap between the acquirer and the target
while Kane (2000) show that gains of the shareholders of the large acquirers are larger after the
in-state mergers. Moreover, Penas and Unal (2004), analyzing the commercial bank mergers be-
tween 1991 and 1998, find that, for an identical increase in size, gains to the bondholders of both
the acquirer and the target around the merger announcement are higher if the merger is an in-state
merger.
For the out-of-market acquirers, the potential for efficiency gains through consolidating operations or closing the least efficient of overlapping branches does not exist. However, the consolidated bank could enjoy other types of cost efficiencies, such as scale economies. Moreover, acquirers might have a very different strategy after out-of-market mergers: in the new markets they enter, they may try to create competition and gain more market share by offering lower rates than the target and the rival banks used to offer before the merger.

Separating in-market mergers and market-extension mergers in the U.S. is a relatively difficult task since most of the banks, especially the larger ones, operate in many markets. As a consequence, the target and the acquirer can overlap in some markets while not overlapping in others. Since branch-level loan data are not available for U.S. commercial banks, FDIC’s Summary of Deposit data was used to get information on the deposit shares of banks instead of loan shares in each market. Using deposits data implicitly assumes that banks generally make loans in the same markets where they collect deposits. This is not an unreasonable assumption since existing empirical evidence shows that banking markets have been highly localized. (See Petersen and Rajan (2002) for small business loan markets.) In the U.S., a banking market is defined in antitrust analysis as the Metropolitan Statistical Area (MSA) or non-MSA rural county. The market overlap between the acquirer and the target was defined by the following formula:

\[ \text{MrktOverlap} = \frac{\sum \min(Deposits_{Acq}, Deposits_{Trgt})}{\sum_n (Deposits_{Acq} + Deposits_{Trgt})} \]

where \( Deposits_{Acq} \) and \( Deposits_{Trgt} \) are, respectively, total deposits of the acquirer and the target in \( n \) markets, in which either acquirer or target operate. \( \text{MrktOverlap}_{\text{Trgt}} \)

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27 A very similar formula using number of branches instead of the total number of deposits is used in Houston and Ryngaert (1997) and Houston, James, and Ryngaert (2001) to identify market overlap.
is constructed by replacing the denominator of the above ratio by the total deposits of the target. Below are the summary statistics of these variables:

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Lower 25th</th>
<th>Upper 25th</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
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<td>MrktOverlap</td>
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<td>0.013</td>
<td>0</td>
<td>0</td>
<td>0.056</td>
<td>0.458</td>
<td>336</td>
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<td>MrktOverlap_Trgt</td>
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<td>0.769</td>
<td>0</td>
<td>0</td>
<td>1</td>
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</tbody>
</table>

In 33% of all mergers, target and acquirer have zero market overlap, and in about 71% of all mergers they overlap less than the mean overlap of 0.044. Descriptive statistics show that the majority of the mergers in my sample are in-market mergers with some, but not full, market overlap, which potentially could explain the average negative change in loan spreads after the mergers in my sample.

In order to analyze how the effect of mergers on loan prices changes as the market overlap between acquirer and target varies, the merger sample was put into categories based on the market overlap. The first group consists of merger-quarters in which the acquirer and the target have zero market overlap before the merger. These are pure market-extension mergers and are called "Out-of-Market Mergers" in this paper. The remaining mergers, which have at least one overlapping market before the merger, are in-market mergers. The subgroup of in-market mergers, for which MrktOverlap is in the upper 25\textsuperscript{th} percentile and MrktOverlap_Trgt is larger than or equal to its mean value, is labeled "In-Market Mergers with Large Market-Overlap." The remaining

\[28\text{ Summary statistics are calculated by using all of the mergers, not the merger-quarters. The total number of mergers decreased by 14 since branch-level deposit data for some of the targets was missing for the relevant year.}\]

\[29\text{ Since the upper 25\textsuperscript{th} percentile value of the MrktOverlap_Trgt is still equal to 1 (full overlap), the only possible cutoff points are median and mean of the ratio. The following analysis constrains In-Market Mergers with Large Overlap to have MrktOverlap_Trgt to be larger than the mean value, but restricting them to be larger than the median value, or MrktOverlap to be larger than its mean value, does not alter the conclusions.}\]
in-market mergers are called “In-Market Mergers with Small Market-Overlap.” Notice that if the acquirer has even a single branch in one of the target’s markets, which is generally the case in the mergers of mega-acquirers of the late 1990s, the consolidation is treated as an in-market merger with small market-overlap.

In order to differentiate mergers with large market overlap, two important restrictions were applied. First, the market overlap between them was restricted to be a significant portion of the total deposits of both banks so that in the markets where they overlap they form bigger banks. Second, this overlap should be a very significant fraction of the total deposits of the targets. When a given acquirer made many mergers within the same quarter, some of their mergers could be in-market while the others could be out-of-market. I exclude from each subsample all merger-quarters that have different types of mergers; however, these merger-quarters were only 12 in number.

The mergers within a given quarter by the same acquirer were mostly either completely in-market or completely out-of-market. But an acquirer could have different types of mergers following each other in a short time. In order to have a clean test of the effects of the different types of mergers, an in-market merger (out-of-market merger) of a given acquirer was included only if it was not less three years after its out-of-market (in-market merger). The final sample consists of 42 “Out-of Market,” 84 “In-Market with Small Market-Overlap,” and 50 “In-Market with Large Market-Overlap” merger-quarters. The possible effects of out-of-market mergers and in-market mergers and the net predicted effect on loan spreads are summarized below.
Table 1.8 analyzes different subsamples of mergers based on the geographical market overlap. Panel A shows the results of the basic regressions (with "After-Merger Dummies") for the "Out-of-Market" subsample. Consistent with the hypotheses, for the mergers where there is zero market overlap, the statistically significant average decline in the spreads is only 7 basis points for small loans within the first year after the merger. In other words, the results both statistically and economically become less significant when only the mergers with zero overlap between acquirer and target markets are considered.

Panel B presents the results of basic regressions for the "In-Market Mergers with Small Market-Overlap." For these types of mergers, there is much more potential for cost declines and not much concern for increase in market power. As presented in the table, the decline in the loan spreads within the first and second year after the merger increase to, respectively, 15 and 15 basis points for all loans and 20 and 19 basis points for small loans. These coefficients are statistically significant at the 1% level, and they are also statistically different from the ones in Panel A. Compared to the market-extension mergers, the reduction in spreads is, as expected, much larger.

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30 Regressions using "After-Last-Merger Dummies" give coefficients that are economically much larger. See Appendix Table for the results.
The last panel of Table 1.8 reports results of the subsample of “In-Market Mergers with Large Market-Overlap.” As explained above, this subsample could include some mergers that have so much overlap as to create some concerns for market power; however, at the same time they enjoy much more potential for efficiency gains. First-, second-, and third-year-after-merger coefficients are, respectively, -5, -4, and -8 basis points for all loans, and -11, -12, and -19 basis points for small loans. The decline in spreads within all three years after the merger is statistically significant at the 5% level for small loans. That means the market power effect is, on average, outweighed by the higher potential for efficiency gains. To check if the upper 25th percentile cut-off (which is 0.056) for significant overlap is high enough to include only the mergers with such significant overlap as to create concerns for market power, Table 1.9 Panel A shows the same regression results using the subsample of mergers where MrktOverlap is in the upper 10th percentile. These mergers, which have much more potential to increase the concentration of banking markets, result, on average, in 13 and 20 basis points higher spreads within the first and third years after the merger, and this statistically significant increase is driven by larger loans.\footnote{Mergers having significant effects on market structure were also identified by calculating the pro forma change in the Hirfindahl-Hirschmann Index (HHI) as described in the literature (see, for instance, Hannan and Prager (1998)). In my sample, there were only 9 mergers that produced a pro-forma increase in target-market HHI of at least 200 points to a post-merger pro forma HHI of at least 1800. Regression analysis using these mergers also results in a statistically significant increase in spreads after the merger.}

1.4.2 The Effect of the Target’s Market Structure

This section will explore the effect of the target’s market structure on some strategic decisions of the acquirer to reduce or increase the loan rates after the merger. As Sapienza (2002) states, “If a bank’s motivation is to gain market share, then it can bring new, aggressive competition to markets that were imperfectly competitive, and it can reduce the possibility of collusive behavior.” However, if a large acquirer is entering into a market dominated by small banks, there would be no need to reduce
spreads to gain market share since a big acquirer would already be more efficient and therefore charging lower prices on a given loan than the prices of the existing smaller competitors.32

Since STBL is biased towards larger banks, most of the acquirers in the sample are large banks, although the size of the targets can vary widely. For all the target markets, using branch-level Summary of Deposits data as of two quarters before the merger, the percentage of deposits held by different sizes of banks is calculated (as in Berger et al. (2001)). “Small Banks’ Markets” are defined as markets in which market shares of small and medium-sized banks (with gross total assets less than $1 billion) are greater than their median market share (0.35) among all the markets of the targets in my sample. “Large Banks’ Markets” are markets dominated by banks with gross assets more than $1 billion.

Table 1.10 presents the results for two subsamples of “Out-of-Market” mergers: mergers into “Small Banks’ Market” and into “Large Banks’ Market.” As shown in Panel A, when out-of-market acquirers enter new markets where there was already large bank dominance, they reduce spreads starting within the first year. This significant reduction within the first year is, on average, 14 basis points for all loans and 19 basis points for large loans. Panel B shows the results for market-extension mergers into Small Banks’ Market, where there is no significant change in the spreads after the mergers.33

Second, the effect of the target’s market structure on the decision to exercise market power is explored. In Panel B of Table 1.9, results for the “In-Market Mergers with Large Overlap” (with overlap in the upper 25th percentile), but only for the

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32 It is empirically shown that large banks charge lower interest rates even for their small business loans (Berger and Udell (1996)).

33 A similar analysis was made for in-market mergers with small overlap. The significant decline in spreads of small loans within the first two years after the merger is statistically very significant for these in-market mergers, independent of the target’s market structure. However, for large loans the change in spreads after these in-market mergers becomes statistically significant within the first year after the merger when the target’s market was dominated by large banks rather than small banks. This result might be interpreted as a strategic price cut, as well.
“Small Banks’ Markets,” are presented. Unlike the whole sample of in-market mergers 
with large (in the upper 25th percentile) overlap, which was presented in Panel C of 
Table 1.8, the market power effect dominates the efficiency effect if the target markets 
are dominated by small banks. Spreads on all loans increase significantly, by 10 basis 
points, and on large loans by 17 basis points within the first year following the merger; 
these results might be due to the lack of other large banks’ competition in the target’s 
markets. The existence of smaller banks rather than big ones could make collusion 
among banks easier and enable a newly formed consolidated bank to increase spreads. 
However, it is worth noting that this regression uses only 19 merger-quarters, which 
constitutes a small fraction of the merger sample.\footnote{As a caveat, there could be some endogeneity issues regarding the type of the merger and the 
structure of the targets’ banking markets, and the results could be due to correlation instead of 
causation. For example, there could be unobservable variables that affect the type of the merger or 
the structure of the targets’ markets and the decline in spreads contemporaneously.}

1.4.3 Potential Changes in Loan Portfolios after In-Market and Out-of-
Market Mergers

Robustness checks for changes in the riskiness of loan portfolios by using the nonper-
forming loans ratio as a left-hand-side (LHS) variable as well as robustness checks for 
changes in ratios of loans with certain characteristics within acquirer’s portfolio (as 
explained in Section 3.4) are done by using only in-market mergers and out-of-market 
mergers. The same checks are done for the subsample of mergers based on market 
structure. Although results are not reported (to save space), the conclusions of this 
section are unaltered; on the contrary, they are strengthened.

1.4.4 Within-Family Mergers

After the banking deregulation, one common type of merger is the consolidation of 
the same banks’ branches, which served in different states as separate banks because 
of the branching restrictions of the period. These \textit{within-family} mergers - were
separated out - are all out-of-market mergers. Given that these two banks (in fact, branches) are expected to share the lending decisions of the same bank in different states before the merger, we do not expect to see any change in their lending behaviors after the merger. This sample of “within-family” mergers is analyzed but not reported in order to save space. The coefficients of all three after-merger dummies are statistically not different from zero for basic regressions including all of the loans and different subsamples of small business loans.

1.5 Is the Reduction in Spreads Due to Efficiency Gains?

Findings based on the market overlap between the acquirer and the target are consistent with what theories imply about the magnitude of the possible efficiency and market power effects; therefore, the decline in the spreads can be attributed to some efficiency gains passed on to the borrowers. However, one alternative explanation for the results might be that complexities after the mergers deteriorate the quality of the banks’ services and the banks cut prices not to lose their borrowers. Hence, the robustness checks below aim to further test the hypothesis that the decline in the spreads is due to efficiency gains reflected in loan rates and these reflections are not temporary.

1.5.1 Cost Efficiencies

As in Focaralli and Panetta (2003), operating-cost ratios for the merging banks were analyzed to further test the hypothesis that the decline in the spreads is due to efficiency gains reflected in loan rates. For that purpose, the operating-cost ratios (operating expense over operating income) of the acquirers as of the second year-end after the merger were compared to the operating-cost ratios of the pro-forma banks (targets plus acquirers) as of the year-end before the merger.\(^{35}\) Although analyzing

\(^{35}\)As a robustness check, operating cost ratio was calculated by using total assets instead of the operating income in the denominator. Conclusions were unaltered.
changes in the operating-cost ratio after the merger is not an ideal to measurement of efficiency gains, one would expect acquirers with a larger decline in operating-cost ratios to reduce spreads more than the acquirers with less decline or even an increase in these cost ratios. Table 1.11 presents the results based on the subsample of mergers, after which “Operating Cost Ratio Declined More than Median” and “Operating Cost Ratio Declined Less than Median” decline in operating cost ratios among all the sample mergers. The decline in spreads is both economically and statistically much larger for the subsample with larger than median decline in the operating cost ratios; and the difference between subsamples is highly significant. The only significant reduction in spreads is observed within the second year after the mergers, resulting in less than median decline in costs, and it is -8 basis points (significant at the 5% level). However, mergers that create more than median cost cuts result in significant decline of 22 and 18 basis points (significant at the 1% level) for small loans within, respectively, the first and second year after the merger as well as 17, 16 (significant at the 1% level), and 11 (significant at the 10% level) basis points for all loans within, respectively, first, second, and third year after the merger. More importantly, if the cost cut is higher, the effects of efficiencies are reflected in large loans as well. Acquirers that enjoy larger than median decline in their operating costs reduce spreads by 14, 19 (significant at the 1% level), and 22 (significant at the 5% level) basis points within, respectively, the first, second, and third year after their mergers.

A second check was constructed based on the following result. Penas and Unal (2004) show that bondholders of merging banks realize the highest returns if the merging banks become “too-big-to-fail” as the result of the merger while already

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36 In order to have a clean test of the effects of these different types of mergers, in Table X, I included the mergers that create larger than median decline in cost-ratios only if this merger is not within three years after another merger of the same acquirer that created smaller than median decline in the cost ratio. The same criterion is used for the latter subsample as well. I ended up with 85 mergers, after which operating cost ratios declined “more than the median” and 81 “less than the median.”
“mega” banks earn relatively lower adjusted returns. There were only 6 acquirers which became mega acquirers (with gross total assets larger than $10 billion) after the mergers; however it is worth noting that the decline in the spreads after the mergers of these banks are on average much larger than after other subsamples of mergers. Large acquirers which become mega acquirers through the mergers reduce spreads on small loans, on average, 42 basis points within the second year and 50 basis points within the third year after the merger. Both of these coefficients are statistically significant at the 1% level.

It is also worth mentioning that the economical significance of the decline in spreads could have been understated since the data do not differentiate loans going to the target’s markets from all other markets of the given acquirer after the merger. Although the technological improvements of the last decade prevent large banks from price discrimination in different banking markets, one would expect the effect on the spreads to be much larger for the targets’ markets than for any other banking market of the acquirer. The fact that the average after-merger decline in spreads is both statistically and economically significant without differentiating banking markets of the acquirer is also supporting the efficiency arguments.

1.5.2 Temporary vs. Persistent Decline in Spreads

In some of the regressions, for example reported in Table 1.3, the significance of the decline in spreads seems to disappear within the third year after the merger although the same decline is both statistically and economically significant within the first and second year after the merger. This raises the question of whether the decline in spreads is temporary or permanent. One might argue that if the decline in spreads disappears after three years, it would not be accurate to conclude that efficiency gains have been passed on to the borrowers, but rather that there were only some strategic price cuts, which are reversed later. In fact, as the event window around the merger
gets longer, it could be more difficult to control for factors other than the merger itself.

Panel A of Table 1.11 clearly shows that when we concentrate on mergers after which the operating cost ratio declines are larger than the median, third-year coefficients are both statistically and economically significant for the all-loans sample as well as the large loans subsample. Although statistically not significant, the coefficient of the third-year after-merger dummy in the small loans subsample is -7 basis points, as well. Similarly, some other subsamples of mergers, for instance, the “Smaller-than-Median Mergers” of a given acquirer (Table 1.4, Panel C) and “In-Market Mergers with Large Overlap” (Table 1.8, Panel C) result in both economically and statistically significant decline in spreads within the third year after the merger. These results constitute important evidence that declines in spreads do not disappear within the third year after the merger. One other subsample presented in Table 1.12 concentrates on our sample excluding mergers of mega acquirers with total gross assets of at least $10 billion. As shown, when the effect of mega-mergers on loan spreads is excluded, mergers result in, on average, about 15 basis points decline for all loans and 13 basis points decline (both significant at the 1% level) for small loans within the third year after the merger, and this decline is persistent after the third year, as well.

Although not reported, the regressions using the subsample of mega acquirers result in a statistically significant decline in spreads within the first year and second year, but an increase in spreads within the third year after the mergers. Consequently, some mega acquirers might be strategically cutting the spreads within the first two years after the merger and then increasing them back to the pre-merger level or even higher levels within the third year; or since these mega acquirers have many mergers in a row, some fundamental factors other than mergers that we cannot control for, could be affecting their loan spreads after three years.

As an alternative, instead of focusing on only three years before and after the
merger, the same set of regressions were run by using a right-hand-side (RHS) variable (All-the-Way after-merger dummy) that is, for a given acquirer, equal to 1 in all the quarters after its first merger, without differentiating the type of the merger, and otherwise is zero. Although not reported, regressions using this all-the-way after-merger dummy variable show a 10 basis points decline (significant at 10% level) for small loans, with loan size less than $1 million, and 13 basis points decline (significant at 5% level) for small loans, with loan size less than $250,000. These results further support that, regardless of the length of the event window analyzed, spreads, on average, decline after consolidation.

As a final check, average two-year and three-year after-merger dummies were examined instead of year-by-year after-merger dummies. After controlling for the loan size, basic regressions including all mergers result in average two-year declines of 12 basis points for all-loans, and 19 basis points for small loans, and average three-year declines of 11 basis points for all-loans and 20 basis points for small loans. All these numbers are statistically significant at the 1% level.

1.6 Deregulation as an Exogenous Instrument for the Timing of Mergers

As mentioned before, the merger sample spans 1990-2000 because of the large increase in the number of mergers in this time period. This increase was mainly due to the removal of intrastate and interstate banking restrictions during the 1980s and early 1990s. Banking literature widely recognized deregulation as the main reason for the merger wave of the last decade (see, for instance, Andrade, Mitchell, and Stafford (2001) for the argument that deregulation is the dominant factor in merger and acquisition activity after the 1980s). However, one might still argue that acquirers could be timing their mergers before the declines in their average spreads. In order to alleviate any concerns regarding the endogeneity of the timing of the mergers in
the sample, the variation in banking deregulation dates across states was used as an instrument for the dates of these mergers. Since the results are driven mostly by in-market mergers, the date (year), in which each state allowed “intrastate branching through mergers and acquisitions” was used as the instrument for the timing of in-market mergers. (The dates of banking deregulation across states are taken from Kroszner and Strahan (1999).)

The results of the first-stage regressions are presented in Panel A of Table 1.13. The regressions are at the market (MSA or non-MSA county) - quarter level. In-Market Mrgr is an indicator variable equal to 1 if in a given quarter at least one merger happened in that given market, and zero otherwise. Count In-Mrkt Mrgr is equal to the total number of acquirers or targets in a given market at a given quarter, and zero otherwise. The right-hand-side (RHS) variables are five after-deregulation dummies, AfterDeregOne - AfterDeregFive, which span five years after the merger and one to five years before the merger (based on data availability). Since it might take a few years after the deregulation to acquire other banks, the time period for after deregulation dummies was extended up to five years. The dummies take the value of 1 for all the quarters within the corresponding year after the intrastate branching deregulation of the state that a given market belongs to, and zero otherwise. Each regression includes time-fixed effects as well as market-fixed effects, and standard errors are corrected for clustering of observations at the state level. As shown in Panel A of Table 1.13, the coefficients of both variables, Count In-Mrkt Mrgr and In-Market Mrgr are significantly positive for the fourth and fifth year after the intrastate deregulation. However, when the predicted values from the first stage are used as the independent variable in the market-quarter level regressions where average Spread per

\footnote{In order to capture more state variation, I extended my data for a few more years, and could capture 22 states that deregulated their “intrastate branching restrictions through mergers” in the time period between 1986 and 1994. This number reduces to 8 states if after-merger dummies were created only for the states deregulated starting 1990, leaving five full years of loan-level data before the first deregulation (since my loan-level data go back to 1985). As a robustness check, I rerun loan-level regressions of the previous sections for this time period and the results remain unaltered.}
market is the dependent variable, the coefficients of the predicted values are negative but not statistically significant at the 10% level. Due to their lack of power, these second-stage regressions are not reported here.

On the other hand, given that the intrastate deregulation can predict merger-events within four and five years’ time, the direct effect of the deregulation on loan spreads is worth exploring. Panel B of Table 1.13 presents the basic regressions of this study, by using after-deregulation dummies instead of the after-merger dummies. The dependent variable is the average Spread per market, collapsed by incorporating some characteristics of loans (whether the loan is secured or not, whether it is under commitment or not, whether it is fixed-rate or not, and whether it is a small-business loan or not). The main independent variables are \( AftrDeregOne - AftrDeregFive \), as defined above. The first column of the panel shows that the average spread significantly declines by 41 basis points within the third year, 55 basis points within the fourth year, and 57 basis points within the fifth year after the intrastate deregulation for the all-loans sample. The statistical significance of the decline is very similar for the small loans, as well; however, the economic magnitudes increase to -54, -71, and -78 basis points, respectively (column (5)). In columns (4) and (6), the same regressions were run by including the natural logarithm of the Hirfindahl-Hirschman Index in order to control that the decline in spreads is not due to the increase in competition after the deregulation. The results were both economically and statistically very similar.\(^{38}\)

\(^{38}\)There were four different types of deregulation: intrastate branching through M&A, full intrastate branching permitted, interstate banking permitted, and multibank holding companies permitted (Kroszner and Strahan (1999)). The instrument used in this paper is the variation in deregulation of intrastate branching through M&A, that is, when states started allowing banks to expand statewide by acquiring other banks. The variation in interstate branching deregulation was also used as an instrument for the timing of mergers in my sample; however, the coefficients were negative but not statistically significant. In-market mergers could happen only after the intrastate deregulation; therefore the fact that intrastate deregulation through M&A works better as an instrument is not surprising.
1.7 Effect of Bank Mergers on Small Business Lending

While favorable effects of mergers on small loan interest rates have been demonstrated, a natural question that remains unanswered is the effect of mergers on the availability of these small loans. STBL data does not have any borrower information, and therefore does not allow tracking what happens to the small borrowers of the pro-forma bank (acquirer plus target before the merger) after the merger. An alternative data source, June Call Reports, is used for this part of the analysis. Since 1993, commercial banks have reported the aggregate amount of loans drawn under credit lines of less than $1 million in their June Call Reports; however, the data are yearly and, unfortunately, became available only after 1993.39

The small business lending of the pro-forma bank, RatioPro-Forma, is simply the sum of the amounts of small business loans (with commitment of less than $1 million) in the portfolios of the acquirer and the target before the merger, over their gross total assets. This ratio is compared to the same ratio of the acquirer after the merger (RatioAfter) in order to see whether some of the small borrowers of the target were dropped from acquirer’s loan portfolio or not. For each merger-year, a mean difference test is run in order to see whether the change in ratios after the merger is significant or not. Since the data are yearly, the test below uses any merger-year, including all the mergers and “within-family” mergers of a given acquirer in a given year.

39Because of ambiguity in the 1993 instructions, which was corrected in 1994, some banks are known to have reported incorrectly in 1993. In order to minimize possibilities of inaccuracy in the data, I dropped observations regarding 1993 from my sample.
The first two rows of the above table report the mean values of the small business lending ratio of the acquirer after the merger and the pro-forma bank before the merger. The first column lists the ratios and mean difference test results for all the merger-years in my sample after 1993 while columns 2 to 4 list the values for subsamples of merger-years based on acquirer size. Mega, Large, and Medium Acquirers are the acquiring banks with gross total assets of at least $10 billion, between $1 billion and $10 billion, and between $100 million and $1 billion, respectively. The mean difference test shows that the change in the mean ratios is negative, but not statistically significant, even for the mega-acquirers subsample. Moreover, analyses of the quantities of small business lending before and after the mergers show that the amount of small business lending of the acquirer increased after the merger. In fact, for 37 of the total 122 merger-years, the change in ratios was positive, meaning that after the mergers some acquirers increased small business lending beyond the small borrowers of the target. While these results provide evidence that after merging with smaller targets, acquirers do not drop all the small business lending of the target, it is possible that they drop very risky borrowers and keep the relatively transparent ones or obtain new small borrowers through the target’s markets. The reason for the increase in small business lending in acquirer’s portfolio could be shifts in lending technologies after the merger, or diversification motives of the acquirer.
Moreover, technological improvements that create opportunities for small business owners to provide more “hard” information about their companies could be the main reason for these small business loans to stay in the large acquirers’ loan portfolios. The findings of this chapter could be indicating that the large banks now value small business lending much more in their portfolios. However, DeYoung et al. (2005) provide empirical evidence that lenders that use credit scoring models experience higher default rates, while Berger et al. (2005a) show that credit scoring is associated with higher prices and more risk for the small loans with loan size less than $100,000. The effect of the latest improvements in small-business-lending technologies on loan portfolios of large banks is a topic worth exploring in further research.

1.8 Conclusion

This chapter supports the hypothesis that bank mergers benefit small borrowers by creating reductions in interest rates on their commercial and industrial loans. This reduction in spreads after the merger is interpreted as some efficiency gains being passed on to the borrowers. These efficiencies could be created by changes in lending technologies (clientele effect) and diversification of risk, which could affect the spreads in a relatively short time after the merger. Furthermore, the reduction in spreads could also be due to scale and/or scope efficiencies, which could take relatively more time to be realized. In order to test the argument that the decline in the spreads is due to efficiency gains reflected in loan rates rather than shifts in borrower quality, the after-merger changes in the operating cost ratios for the merging banks were analyzed. The decline in spreads is both economically and statistically much larger for the mergers with larger-than-median decline in their operating cost ratios than for the mergers with smaller-than-median decline and the difference is highly significant. Furthermore, the decline in the spreads is the most significant for mergers in which acquirer and the target have market overlap before the merger, but not so extensive
as to create concerns for market power effects.

Moreover, the analyses compare the same acquirers before and after the mergers. Since targets have (on average) smaller and riskier loans, the average interest rate in the acquirer’s portfolio is expected to increase after this portfolio is consolidated with that of the target. However, after controlling for the size and some other characteristics of the loans, empirical evidence shows that acquirers charge significantly lower rates on their new loan extensions, and this reduction is driven by small loans.

Although the analysis provides significant evidence for efficiency gains benefiting borrowers as the result of bank mergers, the loan size (which is equal to the total commitment amount if the loan is drawn under commitment and otherwise to the face value) was used as a proxy for the borrower size, instead of the borrower’s own asset size. This leaves open the possibility that the results could be driven by shifts in borrower composition at a given loan size. However, since robustness checks did not show any significant change in the ratio of certain characteristics of loans within a bank’s loan portfolio after the merger, this seems highly unlikely. On the contrary, given the loan size, the ratio of secured loans or floating-rate loans within the acquirer’s portfolio are found to be significantly increasing within the first year after the merger. This would bias results in the opposite direction, since secured loans and floating-rate loans are relatively riskier. Further, the nonperforming loans ratio of the acquirers after the merger does not change at all, ruling out any shifts in the riskiness of the loan portfolio.

In addition to the pricing effect of mergers, the effect on loan availability to small businesses was also explored. After mergers, acquirers might be expected to be dropping all the risky, opaque borrowers in the loan portfolio of the targets. However, the amount of small business lending of the acquirer increases after the merger. Additionally, the average change in the ratio of small business lending of the acquirer after the merger compared to the same ratio of the pro-forma bank (target plus
acquirer) before the merger is not statistically significant at the 10% level. The
data for the quantities of small business lending are available only after 1993, and
this period mostly coincides with the implementation of credit scoring technologies
for commercial loans. Therefore, technological improvements applied to commercial
lending could be the reason for the insignificance of the mean change in small business
lending ratios because these improvements created opportunities for large banks to
acquire more hard information about small businesses.

Contrary to what might be expected by people distrustful of the presumed greater
bargaining power of larger institutions, bigger acquirers do not impose less favorable
pricing terms on small businesses seeking to borrow. Indeed, the findings of this
chapter show that small borrowers typically pay lower interest rates to banks that
have expanded during the previous two years through mergers. The favorable effects
of the mergers reflected in small loan prices could be indicating that the large banks
now value small business lending much more in their portfolios. However, DeYoung
et al. (2005) provide empirical evidence that lenders that use credit scoring models
experience higher default rates, while Berger et al. (2005a) show that credit scoring
is associated with higher prices and more risk for the small loans with loan size less
than $100,000. How improvements in small-business-lending technologies will affect
the composition and the riskiness of large banks’ loan portfolios, is a topic that
deserves further research.
References


Figure 1.1 – **Part of Bank of America Family Tree** (from Figure 32.1 in Brealey, Myers, and Allen (2006))

### Bank of America

<table>
<thead>
<tr>
<th>Security Pacific</th>
<th>First Gibraltar</th>
<th>Continental</th>
</tr>
</thead>
</table>

1998: $61.6 billion  
NationsBank Acquires Bank of America  
Keeps Bank of America Name

<table>
<thead>
<tr>
<th>NCBN</th>
<th>NationsBank</th>
<th>Bank of America</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&amp;S Sovran</td>
<td>BankSouth</td>
<td>Barnett Banks</td>
</tr>
<tr>
<td>1991: $4.3 billion</td>
<td>1994: $1.6 billion</td>
<td>1996: $9.7 billion</td>
</tr>
<tr>
<td>Boatmen's Bancshares</td>
<td>1997: $14.8 billion</td>
<td></td>
</tr>
<tr>
<td>1995: $3.9 billion</td>
<td>Bank Boston</td>
<td></td>
</tr>
<tr>
<td>1999: $15.9 billion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2003: $49.2 billion  
Bank of America  
Acquires FleetBoston

### Fleet Financial Group

<table>
<thead>
<tr>
<th>Norstar Bancorp</th>
<th>Bank of New England</th>
<th>NBB Bancorp</th>
<th>NatWest Bancorp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987: $1.3 billion</td>
<td>1991: bought out of bankruptcy; deal size N/A</td>
<td>1994: $420 million</td>
<td>1995: $3.3 billion</td>
</tr>
</tbody>
</table>

FleetBoston

<table>
<thead>
<tr>
<th>Summit Bankcorp</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000: $7 billion</td>
</tr>
</tbody>
</table>

Source: Thomson Financial SDC M&A Database
The descriptive statistics in Panel A refer to the entire sample of bank-quarters covered by Survey of Terms of Business Lending (STBL) from 1987 to 2003. Panels B and C list the summary statistics for the STBL sample of acquirers and targets, as of one quarter before the merger. Total assets are gross total assets of the bank from Call Reports, and descriptive statistics refer to each bank-quarter. Sum of Total Assets is the quarterly sum of the gross total assets of STBL banks, and the ratio below this variable corresponds to this value expressed as a percentage of all banking assets in a given year. Total assets, total loans and total deposits are all expressed in 2003 dollars by using GDP price deflator. Capitalization is the ratio of equity to gross total assets. ROA is the net income over total assets at the end of the previous year. Non-performing Loans Ratio equals to the ratio of loans 90 days late plus loans not accruing, to the total loans.

### Table 1.1 - Descriptive Statistics of Banks in Survey of Terms of Business Lending (STBL)

The descriptive statistics in Panel A refer to the entire sample of bank-quarters covered by Survey of Terms of Business Lending (STBL) from 1987 to 2003. Panels B and C list the summary statistics for the STBL sample of acquirers and targets, as of one quarter before the merger. Total assets are gross total assets of the bank from Call Reports, and descriptive statistics refer to each bank-quarter. Sum of Total Assets is the quarterly sum of the gross total assets of STBL banks, and the ratio below this variable corresponds to this value expressed as a percentage of all banking assets in a given year. Total assets, total loans and total deposits are all expressed in 2003 dollars by using GDP price deflator. Capitalization is the ratio of equity to gross total assets. ROA is the net income over total assets at the end of the previous year. Non-performing Loans Ratio equals to the ratio of loans 90 days late plus loans not accruing, to the total loans.

<table>
<thead>
<tr>
<th>PANEL A: All Banks in STBL</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>N of Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets ($ million)</td>
<td>9,749</td>
<td>1,202</td>
<td>32,903</td>
<td>4.1</td>
<td>665,928</td>
<td>21,133</td>
</tr>
<tr>
<td>Sum of Total Assets ($ billion)</td>
<td>2,731</td>
<td>2,288</td>
<td>631.5</td>
<td>1,971</td>
<td>4,082</td>
<td>68</td>
</tr>
<tr>
<td>STBL Assets/ All Banks' Assets</td>
<td>0.53</td>
<td>0.52</td>
<td>0.03</td>
<td>0.46</td>
<td>0.6</td>
<td>68</td>
</tr>
<tr>
<td>Total Loans ($ million)</td>
<td>5,608</td>
<td>719</td>
<td>17,749</td>
<td>2</td>
<td>318,575</td>
<td>21,133</td>
</tr>
<tr>
<td>Sum of Total Loans ($ billion)</td>
<td>1,589</td>
<td>1,432</td>
<td>327.4</td>
<td>1,068</td>
<td>2,239</td>
<td>68</td>
</tr>
<tr>
<td>STBL Loans/ All Banks' Loans</td>
<td>0.52</td>
<td>0.52</td>
<td>0.03</td>
<td>0.44</td>
<td>0.58</td>
<td>68</td>
</tr>
<tr>
<td>Total Deposits ($ million)</td>
<td>6,582</td>
<td>977</td>
<td>20,884</td>
<td>3.9</td>
<td>381,235</td>
<td>21,133</td>
</tr>
<tr>
<td>Sum of Total Deposits ($ billion)</td>
<td>1,867</td>
<td>1,670</td>
<td>334</td>
<td>1,376</td>
<td>2,625</td>
<td>68</td>
</tr>
<tr>
<td>STBL Deposits/ All Banks' Deposits</td>
<td>0.50</td>
<td>0.49</td>
<td>0.04</td>
<td>0.43</td>
<td>0.58</td>
<td>68</td>
</tr>
<tr>
<td>Capitalization</td>
<td>0.08</td>
<td>0.08</td>
<td>0.028</td>
<td>0.0002</td>
<td>0.537</td>
<td>21,133</td>
</tr>
<tr>
<td>ROA</td>
<td>0.009</td>
<td>0.01</td>
<td>0.009</td>
<td>-0.18</td>
<td>0.0456</td>
<td>19,414</td>
</tr>
<tr>
<td>Non-Performing Loans Ratio</td>
<td>0.021</td>
<td>0.012</td>
<td>0.027</td>
<td>0</td>
<td>0.53</td>
<td>21,133</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PANEL B: Acquirers in STBL</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>N of Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets ($ million)</td>
<td>16,014</td>
<td>6,100</td>
<td>24,922</td>
<td>145.3</td>
<td>177,083</td>
<td>263</td>
</tr>
<tr>
<td>Total Loans ($ million)</td>
<td>10,290</td>
<td>3,334</td>
<td>16,842</td>
<td>58.9</td>
<td>107,340</td>
<td>263</td>
</tr>
<tr>
<td>Total Deposits ($ million)</td>
<td>11,558</td>
<td>4,730</td>
<td>17,394</td>
<td>125.4</td>
<td>118,532</td>
<td>263</td>
</tr>
<tr>
<td>Capitalization</td>
<td>0.079</td>
<td>0.076</td>
<td>0.016</td>
<td>0.043</td>
<td>0.154</td>
<td>263</td>
</tr>
<tr>
<td>ROA</td>
<td>0.085</td>
<td>0.082</td>
<td>0.013</td>
<td>0.022</td>
<td>0.142</td>
<td>254</td>
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<tr>
<td>Non-Performing Loans Ratio</td>
<td>0.012</td>
<td>0.008</td>
<td>0.012</td>
<td>0.001</td>
<td>0.1</td>
<td>263</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PANEL C: Targets of Acquirers in STBL</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
<th>N of Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets ($ million)</td>
<td>1,419</td>
<td>184</td>
<td>5,738</td>
<td>13.4</td>
<td>43,642</td>
<td>333</td>
</tr>
<tr>
<td>Total Loans ($ million)</td>
<td>809</td>
<td>90.8</td>
<td>3,449</td>
<td>6.58</td>
<td>43,642</td>
<td>333</td>
</tr>
<tr>
<td>Total Deposits ($ million)</td>
<td>1,104</td>
<td>156</td>
<td>4,365</td>
<td>12.2</td>
<td>50,496</td>
<td>333</td>
</tr>
<tr>
<td>Capitalization</td>
<td>0.09</td>
<td>0.085</td>
<td>0.04</td>
<td>0.001</td>
<td>0.32</td>
<td>333</td>
</tr>
<tr>
<td>ROA</td>
<td>0.007</td>
<td>0.009</td>
<td>0.012</td>
<td>-0.18</td>
<td>0.05</td>
<td>321</td>
</tr>
<tr>
<td>Non-Performing Loans Ratio</td>
<td>0.015</td>
<td>0.009</td>
<td>0.019</td>
<td>0</td>
<td>0.13</td>
<td>333</td>
</tr>
</tbody>
</table>
Table 1.2 - Descriptive Statistics of Loan Data

Descriptive statistics refer to the about 2.2 million loan level observations of the Survey of Terms of Business Lending (STBL). First row corresponds to all of the loans covered in the survey, while the rest of the rows differentiate subsamples based on the loan size. Loan size is equal to the total commitment amount when the loan is drawn under commitment and to the face value of the loan otherwise. First column presents the average face value of the loans while the second column lists mean values of total commitment amount for the loans drawn under commitment. Spread, in the third column, is the effective annual interest rate on the loan minus treasury rate of equal duration. And last three columns present bank-quarter level mean values of the percentage of total loans made under commitment, secured by collateral, and with a floating rate. Each variable in the last three columns is weighted by the loan size, as well.

<table>
<thead>
<tr>
<th>Loan Size of,</th>
<th>Average Face Value ($)</th>
<th>Average Commitment Value ($)</th>
<th>Average Spread (%)</th>
<th>Percent of Total Loan Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>Under Commitment (4)</td>
</tr>
<tr>
<td>All Loans</td>
<td>727,143</td>
<td>5,299,670</td>
<td>4.25</td>
<td>0.82</td>
</tr>
<tr>
<td>less than $100,000</td>
<td>25,508</td>
<td>32,374</td>
<td>5.08</td>
<td>0.60</td>
</tr>
<tr>
<td>more than $100,000 &amp; less than $250,000</td>
<td>69,516</td>
<td>181,287</td>
<td>4.69</td>
<td>0.75</td>
</tr>
<tr>
<td>more than $250,000 &amp; less than $1,000,000</td>
<td>128,205</td>
<td>673,184</td>
<td>4.36</td>
<td>0.84</td>
</tr>
<tr>
<td>more than $1 million &amp; less than $25 million</td>
<td>911,396</td>
<td>7,069,819</td>
<td>3.77</td>
<td>0.93</td>
</tr>
<tr>
<td>more than $25 million</td>
<td>8,800,502</td>
<td>62,119,570</td>
<td>2.75</td>
<td>0.96</td>
</tr>
</tbody>
</table>
Table 1.3- The Effect of Bank Mergers on Loan Prices - “All Loans” Sample

The dependent variable is Spread, the effective annual interest rate on the loan minus treasury rate of equal duration. AftrMrgrOne, AftrMrgrTwo and AftrMrgrThree are dummy variables equal to zero for twelve quarters before and after the merger, except that AftrMrgrOne is equal to one for the first four quarters after the merger, AftrMrgrTwo is equal to one for the fifth to eighth quarters after the merger, and AftrMrgrThree is equal to one for the ninth to twelfth quarters after the merger. LoanSize is equal to the natural logarithm of the commitment amount if the loan is under commitment and to the face amount of the loan otherwise. AcquirerSize is the natural logarithm of gross total assets of the acquirer as of. NonperformRatio is nonperforming loans ratio, which is calculated as the sum of loans over 90 days late and loans not accruing over total loans as of t-1. MrgrSize is, in all the quarters within three years before and after the merger, equal to the natural logarithm of the size of the target as of one quarter before the merger, zero otherwise. DummyCommit is equal to one if the loan is under commitment, and zero otherwise. DummyFixed is equal to one if the loan is a fixed-rate loan, and is equal to zero if it is a floating-rate loan. DummySecured is equal to one if the loan is secured by collateral of any kind, zero else. StateDummy is a dummy variable equal to one if the target and the acquirer were in the same state before the merger. MrktHHI is the natural logarithm of the average deposit Hirfindahl-Hirschman Index of the banking-markets of the acquirer. A “merger” event is the consolidation of two banks, in which the charter of the “target” disappears. I do not include the merger quarter in the regressions. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AftrMrgrOne</td>
<td>-0.07**</td>
<td>-0.07**</td>
<td>-0.07**</td>
<td>-0.07**</td>
<td>-0.06</td>
<td>-0.07**</td>
<td>-0.08**</td>
<td>-0.07***</td>
</tr>
<tr>
<td></td>
<td>(-2.03)</td>
<td>(-2.18)</td>
<td>(-2.06)</td>
<td>(-2.25)</td>
<td>(-1.85)</td>
<td>(-2.19)</td>
<td>(-2.38)</td>
<td>(-2.23)</td>
</tr>
<tr>
<td>AftrMrgrTwo</td>
<td>-0.11***</td>
<td>-0.07***</td>
<td>-0.07***</td>
<td>-0.07***</td>
<td>-0.06**</td>
<td>-0.06**</td>
<td>-0.08***</td>
<td>-0.11***</td>
</tr>
<tr>
<td></td>
<td>(-3.47)</td>
<td>(-2.91)</td>
<td>(-2.85)</td>
<td>(-3.21)</td>
<td>(-2.54)</td>
<td>(-2.58)</td>
<td>(-2.92)</td>
<td>(-3.28)</td>
</tr>
<tr>
<td>AftrMrgrThree</td>
<td>-0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.001</td>
<td>0.02</td>
<td>-0.001</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-0.56)</td>
<td>(0.93)</td>
<td>(0.99)</td>
<td>(0.82)</td>
<td>(0.64)</td>
<td>(0.56)</td>
<td>(-0.04)</td>
<td>(-1.13)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.29***</td>
<td>-0.33***</td>
<td>-0.33***</td>
<td>-0.28***</td>
<td>-0.28**</td>
<td>-0.28**</td>
<td>-0.28**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-11.5)</td>
<td>(-11.17)</td>
<td>(-11.14)</td>
<td>(-11.37)</td>
<td>(-13.16)</td>
<td>(-10.67)</td>
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</tr>
<tr>
<td>AcquirerSize</td>
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<td>0.03</td>
<td>0.01</td>
<td>0.001</td>
<td>0.04</td>
<td>-0.002</td>
<td>0.03</td>
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</tr>
<tr>
<td></td>
<td>(1.15)</td>
<td>(0.5)</td>
<td>(0.71)</td>
<td>(0.11)</td>
<td>(0.53)</td>
<td>(-0.04)</td>
<td>(0.5)</td>
<td></td>
</tr>
<tr>
<td>MrgrSize</td>
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<td>0.01</td>
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<td></td>
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<td></td>
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<td></td>
<td>(0.18)</td>
<td>(0.87)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>DumSecured</td>
<td>0.47***</td>
<td>0.49***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(11.24)</td>
<td>(8.16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DumFixed</td>
<td>-0.81***</td>
<td>-0.83***</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-7.24)</td>
<td>(-8.43)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DumCommit</td>
<td>-0.48***</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-4.34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NonperformRatio</td>
<td>1.83</td>
<td>1.15</td>
<td>1.56</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.98)</td>
<td>(0.83)</td>
<td>(1.15)</td>
<td>(1.04)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>StateDummy</td>
<td>-0.09**</td>
<td>-0.07*</td>
<td>-0.06</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(-2.00)</td>
<td>(-1.72)</td>
<td>(-1.51)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MrktHHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.03</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(-0.28)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted R²    0.17  0.35  0.36  0.36  0.35  0.34  0.41  0.23
N of Observations 655,184 655,184 616,347 616,347 619,534 591,533 619,534 619,534

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.4 - The Effect of Bank Mergers on Loan Prices with “After-Merger” vs. “After-Last-Merger” Dummies

“All Mergers” Sample & Subsamples of “Larger Than Median Mergers” and “Smaller than Median Mergers”

The dependent variable is Spread, the effective annual interest rate on the loan minus treasury rate of equal duration. “All Mergers” panel of the table include whole sample of 263 merger-quarters. “Larger-than-Median Mergers” and “Smaller-than-Median Mergers” panels include mergers larger and smaller than median merger of a given bank in terms of total asset size of the targets acquired in a given quarter (136 and 157 mergers, respectively). In the first column of each panel (“After-Merger Dummies”), \(\text{AftMrgrOne, AftMrgrTwo and AftMrgrThree}\) are dummy variables equal to zero for twelve quarters before and after the merger, except that \(\text{AftMrgrOne}\) is equal to one for the first four quarters after the merger, \(\text{AftMrgrTwo}\) is equal to one for the fifth to eighth quarters after the merger, and \(\text{AftMrgrThree}\) is equal to one for the ninth to twelfth quarters after the merger. LoanSize is the natural logarithm of the commitment amount if the loan is drawn under commitment and the face value of the loan otherwise. AcquirerSize is the natural logarithm of gross total assets of the acquirer as of t-1. In the second column of each panel (“After-Last-Merger Dummies”), \(\text{AftMrgrOne, AftMrgrTwo and AftMrgrThree}\) are equal to one as described above only if it is the corresponding year’s after merger dummy of the most recent merger. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th>PANEL A: All Mergers</th>
<th>PANEL B: Larger-than-Median Mergers</th>
<th>PANEL C: Smaller-than-Median Mergers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After-Merger Dummies</td>
<td>After-Last-Merger Dummies</td>
</tr>
<tr>
<td>AftrMrgrOne</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>-0.07***</td>
<td>-0.12***</td>
</tr>
<tr>
<td></td>
<td>(-2.18)</td>
<td>(-2.48)</td>
</tr>
<tr>
<td>AftrMrgrTwo</td>
<td>-0.07***</td>
<td>-0.12**</td>
</tr>
<tr>
<td></td>
<td>(-2.91)</td>
<td>(-2.29)</td>
</tr>
<tr>
<td>AftrMrgrThree</td>
<td>0.03</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(0.93)</td>
<td>(-0.66)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.29***</td>
<td>-0.29***</td>
</tr>
<tr>
<td></td>
<td>(-11.5)</td>
<td>(-12.45)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(0.5)</td>
<td>(0.76)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>N of Observations</td>
<td>655,184</td>
<td>655,184</td>
</tr>
</tbody>
</table>

The symbols *** and ** indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.5 - The Effect of Bank Mergers on Loan Prices - Small vs. Large Loans

This table presents the effect of mergers on the loan spread for different size categories of loans. Different categories are based on loan size, which is equal to the total commitment amount if the loan is drawn under commitment and face value of the loan otherwise. The boundaries of the size categories are listed at the top of each column's regression coefficients. In the first panel ("After-Merger Dummies"), \textit{AftrMrgrOne}, \textit{AftrMrgrTwo} and \textit{AftrMrgrThree} are dummy variables equal to zero for twelve quarters before and after the merger, except that \textit{AftrMrgrOne} is equal to one for the first four quarters after the merger, \textit{AftrMrgrTwo} is equal to one for the fifth to eighth quarters after the merger, and \textit{AftrMrgrThree} is equal to one for the ninth to twelfth quarters after the merger. In the second panel ("After-Last-Merger Dummies"), after merger dummies are equal to one as described above only if it is the corresponding year’s after merger dummy of the most recent merger. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th>PANEL A: After-Merger Dummies</th>
<th>( \leq $100,000 )</th>
<th>( \leq $250,000 )</th>
<th>( \leq $250,000 - $1\text{ Million} )</th>
<th>( \leq $1\text{ Million} )</th>
<th>( &gt; $1\text{ Million} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{LoanSize}</td>
<td>-0.23***</td>
<td>-0.21***</td>
<td>-0.06</td>
<td>-0.15***</td>
<td>0.04</td>
</tr>
<tr>
<td>\textit{AcquirerSize}</td>
<td>0.32***</td>
<td>0.23***</td>
<td>-0.06</td>
<td>0.13**</td>
<td>-0.02</td>
</tr>
<tr>
<td>\textit{Adjusted R^2}</td>
<td>0.24</td>
<td>0.25</td>
<td>0.28</td>
<td>0.27</td>
<td>0.29</td>
</tr>
<tr>
<td>\textit{N. of Observations}</td>
<td>154,137</td>
<td>222,634</td>
<td>135,479</td>
<td>358,113</td>
<td>297,071</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PANEL B: After-Last-Merger Dummies</th>
<th>( \leq $100,000 )</th>
<th>( \leq $250,000 )</th>
<th>( \leq $250,000 - $1\text{ Million} )</th>
<th>( \leq $1\text{ Million} )</th>
<th>( &gt; $1\text{ Million} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{LoanSize}</td>
<td>-0.30***</td>
<td>-0.28***</td>
<td>-0.13**</td>
<td>-0.23***</td>
<td>0.024</td>
</tr>
<tr>
<td>\textit{AcquirerSize}</td>
<td>0.32***</td>
<td>0.24***</td>
<td>-0.03</td>
<td>0.14**</td>
<td>0.002</td>
</tr>
<tr>
<td>\textit{Adjusted R^2}</td>
<td>0.24</td>
<td>0.25</td>
<td>0.28</td>
<td>0.27</td>
<td>0.29</td>
</tr>
<tr>
<td>\textit{N. of Observations}</td>
<td>154,137</td>
<td>222,634</td>
<td>135,479</td>
<td>358,113</td>
<td>297,071</td>
</tr>
</tbody>
</table>

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.6 - The Effect of Bank Mergers on Loan Prices - Different Loan Characteristics

This table shows the effect of mergers on the *spread* on loans of different loan characteristics. In Panel A, our original set of regressions were run first including only the loans drawn under commitment (Loans Under Commitment) and then for loans that are not under commitment (Loans not under Commitment). And Panel B includes same set of regressions for subsamples based on whether the loan is secured or not (Loans Secured by Collateral vs. Loans not Secured by Collateral). *AftrMrgrOne*, *AftrMrgrTwo* and *AftrMrgrThree* are dummy variables equal to zero for twelve quarters before and after the merger, except that *AftrMrgrOne* is equal to one for the first four quarters after the merger, *AftrMrgrTwo* is equal to one for the fifth to eighth quarters after the merger, and *AftrMrgrThree* is equal to one for the ninth to twelfth quarters after the merger. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Small Loans are loans with LoanSize less than $1 Million. Large Loans are loans with LoanSize larger than $1 Million. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

### PANEL A:

<table>
<thead>
<tr>
<th></th>
<th>All Loans</th>
<th>Small Loans</th>
<th>Large Loans</th>
<th>All Loans</th>
<th>Small Loans</th>
<th>Large Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loans</td>
<td>Under</td>
<td>Commitment</td>
<td>Loans</td>
<td>Under</td>
<td>Commitment</td>
</tr>
<tr>
<td>AftrMrgrOne</td>
<td>-0.07</td>
<td>-0.18***</td>
<td>0.04</td>
<td>-0.38***</td>
<td>-0.40***</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(-1.14)</td>
<td>(-2.71)</td>
<td>(0.52)</td>
<td>(-4.89)</td>
<td>(-5.18)</td>
<td>(0.62)</td>
</tr>
<tr>
<td>AftrMrgrTwo</td>
<td>-0.064</td>
<td>-0.154***</td>
<td>0.03</td>
<td>-0.37***</td>
<td>-0.38***</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-1.14)</td>
<td>(-2.87)</td>
<td>(0.39)</td>
<td>(-4.32)</td>
<td>(-4.51)</td>
<td>(-0.27)</td>
</tr>
<tr>
<td>AftrMrgrThree</td>
<td>-0.02</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.08</td>
<td>-0.06</td>
<td>-0.17</td>
</tr>
<tr>
<td></td>
<td>(-0.25)</td>
<td>(-0.22)</td>
<td>(-0.14)</td>
<td>(-0.92)</td>
<td>(-0.66)</td>
<td>(-1.06)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.35***</td>
<td>-0.32***</td>
<td>-0.39***</td>
<td>-0.31***</td>
<td>-0.27***</td>
<td>-0.34***</td>
</tr>
<tr>
<td></td>
<td>(-14.65)</td>
<td>(-10.36)</td>
<td>(-12.42)</td>
<td>(-13.53)</td>
<td>(-11.73)</td>
<td>(-13.23)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>0.02</td>
<td>0.104*</td>
<td>0.003</td>
<td>0.19</td>
<td>0.18</td>
<td>-0.41</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
<td>(1.71)</td>
<td>(0.03)</td>
<td>(1.36)</td>
<td>(1.38)</td>
<td>(-1.35)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.39</td>
<td>0.3</td>
<td>0.29</td>
<td>0.35</td>
<td>0.29</td>
<td>0.48</td>
</tr>
<tr>
<td>N. of Observations</td>
<td>546,421</td>
<td>256,957</td>
<td>289,464</td>
<td>108,763</td>
<td>101,156</td>
<td>7,607</td>
</tr>
</tbody>
</table>

### PANEL B:

<table>
<thead>
<tr>
<th></th>
<th>All Loans</th>
<th>Small Loans</th>
<th>Large Loans</th>
<th>All Loans</th>
<th>Small Loans</th>
<th>Large Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Loans</td>
<td>Secured by</td>
<td>Collateral</td>
<td>Loans</td>
<td>Secured by</td>
<td>Collateral</td>
</tr>
<tr>
<td>AftrMrgrOne</td>
<td>-0.14***</td>
<td>-0.23***</td>
<td>0.00</td>
<td>-0.06</td>
<td>-0.16**</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(-2.86)</td>
<td>(-4.04)</td>
<td>(0.01)</td>
<td>(-0.78)</td>
<td>(-2.22)</td>
<td>(0.88)</td>
</tr>
<tr>
<td>AftrMrgrTwo</td>
<td>-0.15***</td>
<td>-0.21***</td>
<td>-0.025</td>
<td>0.03</td>
<td>-0.05</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(-3.6)</td>
<td>(-4.76)</td>
<td>(-0.4)</td>
<td>(0.27)</td>
<td>(-0.45)</td>
<td>(0.82)</td>
</tr>
<tr>
<td>AftrMrgrThree</td>
<td>-0.11*</td>
<td>-0.10**</td>
<td>-0.065</td>
<td>0.23**</td>
<td>0.24**</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>(-1.86)</td>
<td>(-2.02)</td>
<td>(-0.8)</td>
<td>(2.06)</td>
<td>(2.14)</td>
<td>(1.55)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.24***</td>
<td>-0.18***</td>
<td>-0.26***</td>
<td>-0.41***</td>
<td>-0.43***</td>
<td>-0.42***</td>
</tr>
<tr>
<td></td>
<td>(-8.15)</td>
<td>(-6.0)</td>
<td>(-9.13)</td>
<td>(-19.33)</td>
<td>(-11.28)</td>
<td>(-19.06)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.02</td>
<td>0.34**</td>
<td>0.5***</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(-0.12)</td>
<td>(0.6)</td>
<td>(0.23)</td>
<td>(2.33)</td>
<td>(2.8)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.31</td>
<td>0.26</td>
<td>0.26</td>
<td>0.53</td>
<td>0.39</td>
<td>0.33</td>
</tr>
<tr>
<td>N of Observations</td>
<td>520,786</td>
<td>286,264</td>
<td>234,522</td>
<td>134,396</td>
<td>71,847</td>
<td>62,549</td>
</tr>
</tbody>
</table>

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.7- The Effect of Mergers on Ratios of Certain Types of Loans in Banks’ Portfolio

The dependent variable in Panel A is *Ratio of Secured Loans*, which is the total volume of loans secured by any type of collateral over total volume of loans in given acquirer’s portfolio in a given quarter. The dependent variable in Panel B is *Ratio of Committed Loans*, which is the total volume of loans drawn under commitment over total volume of loans in given acquirer’s portfolio in a given quarter. The dependent variable in Panel C is *Ratio of Floating-rate Loans* in banks’ portfolios, which is the total volume of floating rate loans over total volume of loans in given acquirer’s portfolio in a given quarter. *AfterMrgrOne*, *AfterMrgrTwo* and *AfterMrgrThree* are dummy variables equal to zero for twelve quarters before and after the merger, except that *AfterMrgrOne* is equal to one for the first four quarters after the merger, *AfterMrgrTwo* is equal to one for the fifth to eighth quarters after the merger, and *AfterMrgrThree* is equal to one for the ninth to twelfth quarters after the merger. *LoanSize* is equal to the natural logarithm of the commitment amount if the loan is drawn under commitment and to the face value of the loan otherwise. *AcquirerSize* is the natural logarithm of gross total assets of the acquirer as of t-1. Small Loans are loans with *LoanSize* less than $1 Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

| LHS Variable: | PANEL A: | Ratio of Secured Loans | | | | Ratio of Committed Loans | | | | Ratio of Floating-rate Loans | | |
|---------------|---------|------------------------|---|---|------------------------|---|---|------------------------|---|---|
|               | All Loans | Small Loans | All Loans | Small Loans | All Loans | Small Loans | All Loans | Small Loans | All Loans | Small Loans |
| *AfterMrgrOne* | (1) | 0.03** | (2) | 0.02* | (3) | 0.002 | (4) | 0.00 | (5) | 0.05** | (6) | 0.03* |
|               | (2.24) | (1.85) | (0.12) | (0.00) | (2.45) | (1.92) | -0.02 | -0.01 | -0.11 | 0.40 | 0.02 |
| *AfterMrgrTwo* | 0.003 | 0.002 | -0.02 | -0.01 | -0.44 | 0.64 | 0.04 | 0.02 | 1.59 | 1.23 | |
|               | (0.26) | (0.20) | (-1.09) | (-0.55) | (0.55) | (0.87) | (0.55) | (0.87) | (0.55) | (0.87) | |
| *AfterMrgrThree* | -0.01 | -0.02 | -0.001 | 0.02 | -0.65 | (-0.44) | (-0.44) | (0.64) | (-0.65) | (0.44) | |
| *LoanSize* | -0.004 | -0.02*** | 0.13*** | 0.19*** | 0.004 | 0.05** | 0.02 | 0.02 | 0.02 | 0.02 | |
|               | (-0.37) | (-2.65) | (8.78) | (7.89) | (0.27) | (2.29) | (0.55) | (0.87) | (0.55) | (0.87) | |
| *AcquirerSize* | -0.09 | -0.04** | 0.02 | 0.04 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | |
|               | (-1.63) | (-2.06) | (0.55) | (0.87) | (-0.65) | (0.44) | (-0.65) | (0.44) | (-0.65) | (0.44) | |

| Adjusted R² | 0.47 | 0.33 | 0.67 | 0.67 | 0.45 | 0.46 | | | | | |
| N of Observations | 2,710 | 2,696 | 2,710 | 2,696 | 2,710 | 2,696 | | | | | |

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.8 - The Effect of "In-Market" Mergers vs. "Out-of-Market" Mergers on Loan Prices

The dependent variable is *Spread*, the effective annual interest rate on the loan minus treasury rate of equal duration. *AftMrgrOne*, *AftMrgrTwo* and *AftMrgrThree* are dummy variables equal to zero for twelve quarters before and after the merger, except that *AftMrgrOne* is equal to one for the first four quarters after the merger, *AftMrgrTwo* is equal to one for the fifth to eighth quarters after the merger, and *AftMrgrThree* is equal to one for the ninth to twelfth quarters after the merger. *LoanSize* is equal to the natural logarithm of the commitment amount if the loan is drawn under commitment and to the face value of the loan otherwise. *AcquirerSize* is the natural logarithm of gross total assets of the acquirer as of t-1. Panel A presents my basic results for the subsample of "Out-of-Market" Mergers, in which the acquirer and target have zero market overlap. Panel B shows "In-Market Mergers with Small Market-Overlap", the group of merger-quarters, where the market overlap between the target and the acquirer is within the lower 75th percentile but not zero. "In-Market Mergers with Large Market-Overlap" are the group of merger-quarters, in which the market overlap between target and acquirer is in the upper 25th percentile. Small Loans are loans with *LoanSize* less than $1 Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th>PANEL A:</th>
<th>&quot;Out-of-Market&quot; Mergers</th>
<th>PANEL B:</th>
<th>&quot;In-Market&quot; Mergers with Small Market-Overlap</th>
<th>PANEL C:</th>
<th>&quot;In-Market&quot; Mergers with Large Market-Overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Loans</td>
<td>Small Loans</td>
<td>Large Loans</td>
<td>All Loans</td>
<td>Small Loans</td>
</tr>
<tr>
<td><em>AftMrgrOne</em></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>-0.01</td>
<td>-0.07*</td>
<td>0.09</td>
<td>-0.15***</td>
<td>-0.20***</td>
</tr>
<tr>
<td></td>
<td>(-0.12)</td>
<td>(-1.67)</td>
<td>(1.05)</td>
<td>(-3.81)</td>
<td>(-3.74)</td>
</tr>
<tr>
<td><em>AftMrgrTwo</em></td>
<td>-0.04</td>
<td>-0.04</td>
<td>0.02</td>
<td>-0.15***</td>
<td>-0.19***</td>
</tr>
<tr>
<td></td>
<td>(-0.65)</td>
<td>(-0.72)</td>
<td>(0.27)</td>
<td>(-3.55)</td>
<td>(-3.19)</td>
</tr>
<tr>
<td><em>AftMrgrThree</em></td>
<td>-0.05</td>
<td>-0.01</td>
<td>-0.04</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(-0.53)</td>
<td>(-0.10)</td>
<td>(-0.43)</td>
<td>(0.40)</td>
<td>(0.36)</td>
</tr>
<tr>
<td><em>LoanSize</em></td>
<td>-0.31***</td>
<td>-0.29***</td>
<td>-0.37***</td>
<td>-0.30***</td>
<td>-0.23***</td>
</tr>
<tr>
<td></td>
<td>(-10.61)</td>
<td>(-7.49)</td>
<td>(-7.03)</td>
<td>(-6.52)</td>
<td>(-4.38)</td>
</tr>
<tr>
<td><em>AcquirerSize</em></td>
<td>-0.10</td>
<td>-0.01</td>
<td>-0.12</td>
<td>0.29***</td>
<td>0.27**</td>
</tr>
<tr>
<td></td>
<td>(-1.24)</td>
<td>(-0.15)</td>
<td>(-0.83)</td>
<td>(2.57)</td>
<td>(2.16)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.36</td>
<td>0.31</td>
<td>0.25</td>
<td>0.36</td>
<td>0.27</td>
</tr>
<tr>
<td>N of Observations</td>
<td>241,195</td>
<td>118,403</td>
<td>122,792</td>
<td>296,165</td>
<td>179,259</td>
</tr>
</tbody>
</table>

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.9- The Effect of “In-Market Mergers with Large Overlap” on Loan Prices

The dependent variable is Spread, the effective annual interest rate on the loan minus treasury rate of equal duration. AfterMrgrOne, AfterMrgrTwo and AfterMrgrThree are dummy variables equal to zero for twelve quarters before and after the merger, except that AfterMrgrOne is equal to one for the first four quarters after the merger, AfterMrgrTwo is equal to one for the fifth to eighth quarters after the merger, and AfterMrgrThree is equal to one for the ninth to twelfth quarters after the merger. LoanSize is the natural logarithm of the commitment amount if the loan is drawn under commitment and the face value of the loan otherwise. AcquirerSize is the natural logarithm of the gross total assets of the acquirer as of t-1. “In-Market Mergers with Market-Overlap in Upper 10th Percentile” are the group of merger-quarters, in which the market overlap between target and acquirer is in the upper 10th percentile. “In-Market Mergers with Large Market-Overlap” are the group of merger-quarters, in which the overlap between target and acquirer is in the upper 25th percentile and “Small Banks’ Market” is the target markets, dominated by small banks, with gross total assets of less than $1 billion. Small Loans are loans with LoanSize less than $1 Million. Large Loans are loans with LoanSize larger than $1 Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th></th>
<th>PANEL A: In-Market Mergers with Market-Overlap in Upper 10th Percentile</th>
<th>PANEL B: &quot;In-Market Mergers with Large Market-Overlap&quot; in &quot;Small Banks’ Market&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Loans</td>
<td>Small Loans</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>AfterMrgrOne</td>
<td>0.13**</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(2.29)</td>
<td>(0.76)</td>
</tr>
<tr>
<td>AfterMrgrTwo</td>
<td>0.09</td>
<td>-0.28</td>
</tr>
<tr>
<td></td>
<td>(1.49)</td>
<td>(-0.02)</td>
</tr>
<tr>
<td>AfterMrgrThree</td>
<td>0.20**</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(2.21)</td>
<td>(1.07)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.26***</td>
<td>-0.21***</td>
</tr>
<tr>
<td></td>
<td>(-7.78)</td>
<td>(-4.31)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>-0.32**</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(-2.33)</td>
<td>(-0.76)</td>
</tr>
</tbody>
</table>

Adjusted R²: 0.33  0.2  0.29  0.3  0.15  0.30

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.10: The Effect of “Out-of-Market” Mergers on Loan Prices - Incorporating the Targets’ Market Structure

The dependent variable is Spread, the effective annual interest rate on the loan minus treasury rate of equal duration. AftMrgrOne, AftMrgrTwo and AftMrgrThree are dummy variables equal to zero for twelve quarters before and after the merger, except that AftMrgrOne is equal to one for the first four quarters after the merger, AftMrgrTwo is equal to one for the fifth to eighth quarters after the merger, and AftMrgrThree is equal to one for the ninth to twelfth quarters after the merger. LoanSize is the natural logarithm of the commitment amount if the loan is drawn under commitment and the face value of the loan otherwise. AcquirerSize is the natural logarithm of gross total assets of the acquirer as of t-1. “Out-of-Market” mergers are market extension mergers where the acquirer and target have zero market overlap before the merger. Panel A shows the results for the subsample of out-of-market mergers into “Large Banks’ Market”, where target’s markets were dominated by large banks, with gross total assets of at least $1 billion. The regression results of mergers into “Small Banks’ Market”, the target markets dominated by small banks with gross total assets of less than $1 billion, are shown in Panel B. Small Loans are loans with LoanSize less than $1 Million. Large Loans are loans with LoanSize larger than $1 Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th></th>
<th>&quot;Out-of-Market&quot; Mergers into Large Banks' Market</th>
<th>&quot;Out-of-Market&quot; Mergers into Small Banks' Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Loans</td>
<td>Small Loans</td>
</tr>
<tr>
<td>AftMrgrOne</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>-0.14**</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(-2.17)</td>
<td>(-1.38)</td>
</tr>
<tr>
<td>AftMrgrTwo</td>
<td>-0.07</td>
<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-0.81)</td>
<td>(-0.56)</td>
</tr>
<tr>
<td>AftMrgrThree</td>
<td>-0.12</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(-0.65)</td>
<td>(-0.17)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.33***</td>
<td>-0.44***</td>
</tr>
<tr>
<td></td>
<td>(-9.4)</td>
<td>(-8.11)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>-0.08</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(-0.54)</td>
<td>(-0.17)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.45</td>
<td>0.31</td>
</tr>
<tr>
<td>N of Observations</td>
<td>92,651</td>
<td>46,438</td>
</tr>
</tbody>
</table>

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.11 - Cost Efficiencies

The dependent variable is \textit{Spread}, the effective annual interest rate on the loan minus treasury rate of equal duration. \textit{AftMrgrOne}, \textit{AftMrgrTwo} and \textit{AftMrgrThree} are dummy variables equal to zero for twelve quarters before and after the merger, except that \textit{AftMrgrOne} is equal to one for the first four quarters after the merger, \textit{AftMrgrTwo} is equal to one for the fifth to eighth quarters after the merger, and \textit{AftMrgrThree} is equal to one for the ninth to twelfth quarters after the merger. \textit{LoanSize} is the natural logarithm of the commitment amount if the loan is drawn under commitment and the face value of the loan otherwise. \textit{AcquirerSize} is the natural logarithm of the gross total assets of the acquirer as of \textit{t-1}. This table is constructed by comparing the operating-cost ratio (operating expense over operating income) of the acquirer as of the second year end after the merger to the operating-cost ratio of the pro-forma bank (target plus acquirer as of the year end before the merger). Panel A covers the mergers, after which "Cost Ratio Declined More than Median" decline in operating cost ratio among all the mergers in the sample. Panel B shows the regression results for the mergers, after which "Cost Ratio Declined Less than Median" decline in operating cost ratio among all the mergers in the sample. Small Loans are loans with \textit{LoanSize} less than $1$ Million. Large Loans are loans with \textit{LoanSize} larger than $1$ Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th>Mergers after which</th>
<th>Operating Cost Ratio Declined More than Median</th>
<th>vs.</th>
<th>Operating Cost Ratio Declined Less than Median</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Loans</td>
<td>Small Loans</td>
<td>Large Loans</td>
</tr>
<tr>
<td>\textit{AftMrgrOne}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>\text{(-5.16)}</td>
<td>-0.174***</td>
<td>-0.22***</td>
<td>-0.14***</td>
</tr>
<tr>
<td>\text{(-3.14)}</td>
<td>-0.164***</td>
<td>-0.18***</td>
<td>-0.19***</td>
</tr>
<tr>
<td>\text{(-1.95)}</td>
<td>-0.11*</td>
<td>-0.07</td>
<td>-0.22**</td>
</tr>
<tr>
<td>\text{(-6.51)}</td>
<td>-0.30***</td>
<td>-0.23***</td>
<td>-0.39***</td>
</tr>
<tr>
<td>\text{(-3.87)}</td>
<td>-0.07</td>
<td>0.10</td>
<td>0.16**</td>
</tr>
<tr>
<td>\text{(-1.23)}</td>
<td>(1.17)</td>
<td>(1.23)</td>
<td>(2.27)</td>
</tr>
<tr>
<td>\text{(-0.33)}</td>
<td>(1.53)</td>
<td>(1.53)</td>
<td>(0.81)</td>
</tr>
</tbody>
</table>

| \text{Adjusted R}^2 | 0.36 | 0.27 | 0.28 | 0.33 | 0.25 | 0.26 |
| \text{N of Observations} | 327,874 | 180,861 | 147,013 | 290,963 | 165,857 | 125,106 |

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.12 - The Effect of Bank Mergers on Loan Prices - Mega Acquirers Excluded

This table shows the results of my basic regressions, with Spread as the dependent variable, by excluding the mega acquirers. Mega acquirers are the acquiring banks with total gross assets larger than $10 billion. AftrMrgrOne, AftrMrgrTwo and AftrMrgrThree are dummy variables equal to zero for twelve quarters before and after the merger, except that AftrMrgrOne is equal to one for the first four quarters after the merger, AftrMrgrTwo is equal to one for the fifth to eighth quarters after the merger, and AftrMrgrThree is equal to one for the ninth to twelfth quarters after the merger. LoanSize is the natural logarithm of the commitment amount if the loan is drawn under commitment and the face value of the loan otherwise. AcquirerSize is the natural logarithm of gross total assets of the acquirer as of t-1. Small Loans are loans with LoanSize less than $1 Million. Large Loans are loans with LoanSize larger than $1 Million. All the regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th>Without the Mergers of Mega Acquirers</th>
<th>All Loans</th>
<th>Small Loans</th>
<th>Large Loans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>AftrMrgrOne</td>
<td>-0.02</td>
<td>-0.09*</td>
<td>0.09*</td>
</tr>
<tr>
<td></td>
<td>(-0.48)</td>
<td>(-1.77)</td>
<td>(1.75)</td>
</tr>
<tr>
<td>AftrMrgrTwo</td>
<td>-0.05</td>
<td>-0.09*</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(-0.96)</td>
<td>(-1.66)</td>
<td>(0.85)</td>
</tr>
<tr>
<td>AftrMrgrThree</td>
<td>-0.15***</td>
<td>-0.16***</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(-2.83)</td>
<td>(-3.31)</td>
<td>(-0.89)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.26***</td>
<td>-0.20***</td>
<td>-0.38***</td>
</tr>
<tr>
<td></td>
<td>(-12.75)</td>
<td>(-7.96)</td>
<td>(-15.80)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>0.15</td>
<td>0.20*</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>(1.53)</td>
<td>(1.74)</td>
<td>(1.01)</td>
</tr>
</tbody>
</table>

Adjusted R²  | 0.35  | 0.25  | 0.32  |
N of Observations | 304,615 | 175,062 | 129,553 |

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
Table 1.13- Dates of Banking Deregulation as an Instrument for the Timing of Mergers

Panel A shows the first-stage regression results. The dependent variable in Column (1) is *In-Market Mrgr*, which is an indicator variable equal to 1 if at a given quarter at least one merger happened in that given market, zero otherwise. The dependent variable in Column (2), *Count In-Mrkt Mrgr*, is equal to the total number of acquirers or targets in a given market at a given quarter and zero otherwise. *AftDeregOne - AftDeregFive* span five years before and after the intrastate deregulation: take the value of 1 for all the quarters within the first-fifth year after the branching deregulation of the state that a given market belongs to and zero otherwise. The predicted values from the first stage are used as an independent variable in the second stage, where average spread per market is the dependent variable. However, the second stage lacks power (therefore not reported) and results in negative but insignificant coefficient for the predicted values of the first-stage regression. Panel B shows the direct effect of deregulation on loan spreads. Dependent variable is *Spread*, the normalized effective rate, averaged by market (MSA or non-MSA county) incorporating some characteristics of loans (whether it is secured or not, whether it is under commitment or not, whether it is fixed rate or not and whether it’s small-business loan or not). *HirfindahlIndex* is the natural logarithm of the Hirfindahl-Hirschman Index of each market. These regressions use quarterly market level data and they all include time fixed effects (quarter dummies) as well as market fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the state level.

| PANEL A: LHS Variable: |  | PANEL B: LHS Variable: |
|------------------------|  |------------------------|
| **In Market Mrgr**     | **Count In Mrkt Mrgr** | **Spread** |
| All Mergers (1)        | All Mergers (2)        | All Loans (3) |
| *AftDeregOne*          | (-0.07)                | -0.06 |
| (-0.00)                | (0.17)                 | (-0.47) |
| *AftDeregTwo*          | 0.0045                 | -0.18 |
| (1.27)                 | (1.3)                  | (-0.96) |
| *AftDeregThree*        | 0.001                  | -0.41* |
| (0.19)                 | (0.58)                 | (-1.64) |
| *AftDeregFour*         | 0.007*                 | -0.55** |
| (1.70)                 | (1.82)                 | (-1.99) |
| *AftDeregFive*         | 0.011**                | -0.57* |
| (2.00)                 | (2.15)                 | (-1.87) |
| **LoanSize**           | -0.30***               | -0.55* |
| (-11.69)               | (-11.69)               | (-1.79) |
| **AcquirerSize**       | -0.12***               | -0.78* |
| (-3.78)                | (-3.76)                | (-1.84) |
| **HirfindahlIndex**    | 0.09                   | -0.20*** |
| (1.22)                 | (-4.84)                | (-4.84) |
| Adjusted R2            | 0.08                   | -0.125*** |
| N of Observations      | 49,124                 | (-5.16) |
|                         | 49,124                 | (-5.14) |
|                         | 43,429                 | 0.28    |
|                         | 43,429                 | 0.28    |
|                         | 28,471                 | 28,471  |
Appendix Table- The Effect of “In-Market” Mergers vs. “Out-of-Market” Mergers on Loan Prices with “After-Last-Merger” Dummies

The dependent variable is Spread, the effective annual interest rate on the loan minus treasury rate of equal duration. “After-Last-Merger” Dummies concentrate on only the most recent merger of a given acquirer, and they are constructed as follows. AfterMrgrOne, AfterMrgrTwo and AfterMrgrThree are dummy variables equal to zero for twelve quarters before and after the merger, except that AfterMrgrOne is equal to one for the first four quarters after the merger, AfterMrgrTwo is equal to one for the fifth to eighth quarters after the merger only if these quarters do not coincide with the first four quarters of the most recent merger of the same acquirer, and AfterMrgrThree is equal to one for the ninth to twelfth quarters after the merger only if these quarters do not coincide with the first eight quarters of the most recent merger of the same acquirer. LoanSize is equal to the natural logarithm of the commitment amount if the loan is drawn under commitment and to the face value of the loan otherwise. AcquirerSize is the natural logarithm of gross total assets of the acquirer as of t-1. Panel A presents my basic results for the subsample of “Out-of-Market” Mergers, in which the acquirer and target have zero market overlap. Panel B shows “In-Market Mergers with Small Market-Overlap”, the group of merger-quarters, where the market overlap between the target and the acquirer is within the lower 75th percentile but not zero. “In-Market Mergers with Large Market-Overlap” are the group of merger-quarters, in which the market overlap between target and acquirer is in the upper 25th percentile. Small Loans are loans with LoanSize less than $1 Million. All regressions use quarterly loan level data and they all include time fixed effects (67 quarter dummies) as well as bank fixed effects. Heteroscedasticity-robust t-statistics are in parentheses. Standard errors are corrected for clustering of observations at the bank level.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Loans</td>
<td>Small Loans</td>
<td>Large Loans</td>
</tr>
<tr>
<td>AfterMrgrOne</td>
<td>-0.04</td>
<td>-0.09*</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(-0.49)</td>
<td>(-1.8)</td>
<td>(0.66)</td>
</tr>
<tr>
<td>AfterMrgrTwo</td>
<td>-0.09</td>
<td>-0.07</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(-1.16)</td>
<td>(-0.86)</td>
<td>(-0.33)</td>
</tr>
<tr>
<td>AfterMrgrThree</td>
<td>-0.12</td>
<td>-0.05</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(-1.27)</td>
<td>(-0.52)</td>
<td>(-1.07)</td>
</tr>
<tr>
<td>LoanSize</td>
<td>-0.31***</td>
<td>-0.29***</td>
<td>-0.374***</td>
</tr>
<tr>
<td></td>
<td>(-10.61)</td>
<td>(-7.49)</td>
<td>(-7.02)</td>
</tr>
<tr>
<td>AcquirerSize</td>
<td>-0.12</td>
<td>-0.02</td>
<td>-0.13</td>
</tr>
<tr>
<td></td>
<td>(-1.47)</td>
<td>(-0.31)</td>
<td>(-0.92)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.36</td>
<td>0.31</td>
<td>0.25</td>
</tr>
<tr>
<td>N of Observations</td>
<td>241,195</td>
<td>118,403</td>
<td>122,792</td>
</tr>
</tbody>
</table>

The symbols ***, ** and * indicate statistical significance at the 1, 5 and 10 percent level, respectively.
2 Chapter 2

Incentive-based Regulation of Banks:  
An Interpretation of Basel II

2.1 Introduction

This chapter models banks’ incentives for "regulatory capital arbitrage" under the current capital adequacy rules. Because the risk exposures of different types of banks cannot be precisely measured, banks making risky investments pool with the banks investing safely so that they can be subject to a lower amount of regulatory capital. The new Basel II rules are an attempt to solve these problems with the current system. I show that Basel II’s Internal Ratings-based (IRB) Approach can be interpreted as a way of forcing a separating equilibrium in which good banks that do not pursue unduly risky strategies identify themselves to the regulators and are rewarded with a lower capital requirement.

Current capital adequacy regulations define risk categories for bank assets based on their observable characteristics. Assets in the riskier categories receive higher risk weights. The categories are broad, however, and banks can substitute high-risk assets for low-risk assets within each category, with no requirement to increase their risk-based capital. This risk-shifting is known as "regulatory capital arbitrage" (RCA), and is driven by the difference between a bank’s actual economic risk exposures and the exposures as assessed by the regulators. As pointed out by Jones (2000), these divergences enable banks to repack their portfolio risks in order to hold much less capital than implied by the economic risks incurred. RCA is implemented by unbundling and repackaging risks of assets, for example, through securitization of the banks’ highest quality assets ("cherry-picking"), so that a portion of the credit risk of the bank loans is treated as if these loans belonged to an asset category with
lower risk weights, consequently lowering effective capital requirements for these risky assets.

In response to criticisms of the current capital requirements that as crude rules they introduce divergences between economic risks and their regulatory counterparts, the Basel Committee on Banking Supervision released a proposal of amendment, known as "Basel II." The Committee completed the new Accord in June 2004 and implementation is intended to take effect in member countries by year-end 2006.\textsuperscript{40}

Under the new Accord, there are primarily two approaches to defining the capital requirements. First is the "Standardized Approach," which slightly modifies the current risk-based system by adding, based on the estimates of some private credit agencies, new risk categories to evaluate the risk-weighted asset portfolios of banks. However, the change is a very superficial one since the new risk weights continue to allow only a very limited number of categories.

Second is the "Internal Ratings-based (IRB) Approach," which will be an alternative option for banks that satisfy an infrastructure requirements. Under the IRB approach, if a bank’s risk estimate models meet the criteria of the supervisors, the bank will be allowed to use its internal risk measurement models in order to assess the riskiness of its loan portfolios and estimate its required amount of capital. The IRB approach will be a more supervision-oriented system, in which supervisors check whether banks that decide to opt in have adequate levels of risk measurement infrastructure, and based on the risk estimates of the approved banks, interactively set the relevant capital requirements for them. The main criticism of this approach is the possibility that banks will mislead the regulator about risk estimates. (See, for instance, Danielsson et al. (2001) and Ward (2002), whose arguments will be described in section 2.4.)

This chapter offers a different perspective on Basel II. Contrary to what might be

\textsuperscript{40}See Basel Committee on Banking and Supervision (2003) for an overview of the new Basel Capital Accord.
expected, Basel II does not create incentives for all types of banks to use their own internal risk measurement models and to truthfully report their correct credit and market risk values. Indeed, the changes coming with Basel II could be interpreted as an attempt to reach a more efficient separating equilibrium, in which banks investing safely choose to adopt their own internal risk measurement systems, while banks making highly risky investments choose to stay with the old standardized system.

The argument is simple. Banks invest in an optimal portfolio of positive NPV good loans and zero NPV risky loans. Given the existence of the deposit insurance guarantee by the regulator, the tradeoff between the risk-shifting incentives and the continuation value can make banks choose corner solutions. Some banks choose to invest only in good loans in order to preserve their continuation value by minimizing their bankruptcy probability. On the other hand, some banks invest heavily in risky loans in order to exploit the deposit insurance provided by the regulator. If these good and risky loans are subcategories of the same asset-risk category, the regulator cannot see the details within the risk category and consequently does not know which type of bank he or she is dealing with. The current capital requirements lead to an inefficient pooling equilibrium, in which banks making highly risky investments pretend to be investing safely in order to have the same capital requirement as banks making safer investments. This equilibrium is socially costly for two main reasons. First, holding equity size constant, the increase in the capital requirements for safe banks puts an upper bound on bank assets, and consequently on good loans to entrepreneurs. Second, the decline in the capital requirements for risky banks increases their probability of bankruptcy, which is already much higher than that for safe banks, and hence the probability that deadweights costs of bankruptcy in addition to some other costs due to loss of fixed capital are incurred in the economy.

Under Basel II, the regulator will offer banks an option to switch to their own internal risk models as long as they satisfy some infrastructure criteria. Safe banks,
by exercising this option, can identify themselves to the regulator. The banks that choose to use their internal risk models will be under close supervision. However, the information asymmetry problem of the current system will not be totally eliminated because of the difficulty of implementing an efficient back-testing. Therefore, risky banks can try to opt into the IRB approach and misreport the risk estimates. However, given that supervisors will visit banks more often and work closely with them on setting capital ratios, there will be some probability that a bank pretending to be investing safely, but in fact making highly risky investments, would be caught by the supervisors. Additionally, banks will incur high set-up costs in order to meet the infrastructure criteria for risk estimation and also will incur continuous supervision costs. Given these costs, if all the safe banks switch to the IRB approach, risky banks will be better off trying to opt into the IRB approach, instead of staying in the standardized approach and thereby identifying themselves as risky banks to the regulator. To avoid this inefficient pooling, the regulator can create incentives for the risky banks not to switch to using their internal risk measurement models by setting the capital requirements for the risky banks lower than their first-best. Thus, a separating equilibrium, in which safe banks identify themselves by adopting the IRB approach, can be sustained.41

The remainder of the chapter is organized as follows. Section 2.2 reviews the existing literature on risk taking, banking regulation, and capital requirements. Section 2.3 describes the main players of the model and shows the inefficient pooling equilibrium under the current capital requirements. Section 2.4 analyzes Basel II and derives the separating equilibrium and the conditions to sustain this equilibrium, and also briefly summarizes the planned implementation of the Basel II rules in the U.S.

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41 The implementation of the Basel II rules in the U.S. will be slightly different from the proposed Accord since about the ten largest banking firms in the U.S. will be obliged to adopt the IRB approach. That is because the regulators want these largest banks to invest in their internal risk assessment systems since they constitute the core of the U.S. financial system. Other banks will be given the option to switch to the IRB approach as long as they meet the infrastructure criteria.
Section 2.5 concludes the chapter.

2.2 Relationship to Existing Literature

Bhattacharya and Thakor (1993), Freixas and Rochet (1997), Santos (2000), and Palia and Porter (2003) provide reviews of the banking literature and contemporary issues in bank capital regulation. Moral hazard under the fixed-rate deposit insurance system was first formalized by Merton (1977), which shows that deposit insurance can be viewed as a put option on the value of banks’ assets, with a strike price equal to the promised maturity value of its debt. Under the Federal Deposit Insurance Corporation’s fixed-rate deposit insurance system, banks are tempted to borrow at or below the risk-free rate through insured deposits, and invest in risky assets in order to maximize the value of this put option, and consequently their equity, by increasing the risk of their asset portfolios. (See Kane (1985), Keeley (1990), Flannery (1991), and Cole et al. (1995) for the incentives to take on excessive risk ("gambling for resurrection") that the deposit insurance system with insurance premiums independent of risk creates.)

The Basel Accord imposes capital adequacy requirements on banks in an effort to control these moral hazard problems. In order to be compatible with the current regulatory system, this study takes the existence of the fixed-rate deposit insurance as given and assumes that the guarantor of the deposit insurance aims to adjust capital requirements, instead of the deposit insurance premiums, in order to set the expected capital requirements.

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42 See also Chan, Greenbaum and Thakor (1992) arguing that in the presence of moral hazard and adverse selection of banks, fairly priced deposit insurance may be impossible. However, Giammarino, Lewis, and Sappington (1993) shows an optimal design of risk-adjusted deposit insurance in the presence of adverse selection and moral hazard.

43 The 1988 Basel Capital Accord (the "Accord"), elaborated by the Basel Committee on Banking Supervision (BCBS), required banks of the G10 countries to hold capital equal to at least 8% of their risk-adjusted assets. These prudential regulations were adopted in the U.S. through the FDIC Improvement Act in 1991. With the 1997 Market Risk Amendment, capital adequacy rules were amended to cover market risk. See Basel Committee on Banking Supervision (1988, 1997).
loss of providing deposit guarantee equal to zero.\textsuperscript{44}

There are many papers showing that, contrary to what is intended, capital adequacy requirements fail to control risk taking. (See, for example, Koehn and Santomero (1980), Kim and Santomero (1988), Genotte and Pyle (1991), Rochet (1992), Berger, Herring and Szego (1995), Besanko and Kanatas (1996), and Blum (1999).) While one side of the banks' trade-off, which affects their investment choices, is this risk-shifting incentive, the other side of the trade-off is the loss of charter value in case of bankruptcy. The discounted stream of current and future rents on real loans is called charter (franchise) value in the banking literature, and since this charter value is lost when the bank goes bankrupt, it creates incentives for the banks to choose more conservative levels of risk and leverage. (See, for instance, Furlong and Keeley (1989), Keeley (1990), Hellmann, Murdock, and Stiglitz (2000), Pelizzon (2001), Gan (2004), and Repullo (2004).) This study does not question the validity of capital requirements as a regulatory mechanism, but analyzes the regulatory capital arbitrage incentives that the current system creates.

Since this study has a dynamic setting, which is relatively uncommon in the literature, the model endogenizes the charter (franchise) value of the bank. The dynamic nature of the model set-up is similar to Hellman, Murdock, and Stiglitz (2000), which shows that capital requirement regulation without a deposit rate ceiling yields inefficient outcomes. However, the essence of my study, which is about the regulatory capital arbitrage incentives of the banks, is the asymmetric information within a risk category. Therefore, the model should incorporate at least two different assets with both random returns and positive variances. In Hellman, Murdock, and

\textsuperscript{44}Allen and Gale (2003) argue that one bad policy (deposit insurance) should not justify others and in the absence of welfare-relevant pecuniary externality, banks would choose their socially optimal capital structure themselves, without government intervention. Their argument is based on assumptions of complete markets and the absence of financial crises. This paper does not question the validity of the deposit insurance. See the seminal paper of Diamond and Dybvig (1983) for an explicit model of the rationale for its existence. And see also Dewatripont and Tirole (1994) for a representation theory of banking regulation, in which the prudential regulation aims to protect the interests of the depositors while avoiding bank-runs.
Stiglitz (2000), the prudent asset has a constant return, and the gambling asset has binomial payoffs. Such a set-up would help the regulator infer, after just a few periods, which asset the bank is investing in, and therefore would not be applicable to this study. Moreover, in my model, the probability of bankruptcy depends on the random returns as well, while it is fixed in their model. Pelizzon (2001) also uses a similar dynamic model and comes up with a similar value function to this chapter's in order to show how different sources of rents ("underpriced deposit insurance, supernormal returns on banks, and imperfect competition for deposits") affect banks' risk-taking behavior. In her model, although there is one risky asset that has a random return, the second asset is a risk-free bond, which again would not be compatible with this study's premise of asymmetric information between the banks and the regulator. To my knowledge, this is the first study that both formally models regulatory capital arbitrage within a risk category in a dynamic setting, and also analytically shows the separating equilibrium interpretation of the Basel II rules.

There is an extensive literature analyzing both the movement towards using one's own internal risk models instead of the "one-size-fits-all" approach and also the newly proposed accord, Basel II. There are two main criticisms of using internal risk models. The first concerns the drawbacks of all possible risk estimation models (see Kupiec and O'Brien (1995a), Rochet (1999), Danielsson (2000), Embrechts, McNeil and Straumann (2000), and Danielsson et al. (2001)). The second concerns the cyclical implications of Basel II standards: the argument is that the new capital standards will exacerbate business cycles (see Danielsson et al. (2001), Danielsson, Shin, and Zigrand (2002), Ward (2002b), Danielsson and Zigrand (2003), Kashyap and Stein (2004), and Gordy and Howells (2004)). This study does not argue that Basel II regulations will be the most efficient system of regulation. It shows that under Basel II rules, it is possible to have a more efficient separating equilibrium than the inefficient pooling equilibrium of the current system if high supervision criteria are met. By
suggesting such a different interpretation of Basel II, this study also exempts itself from the above criticisms.

An alternative to internal risk models approach was suggested by Kupiec and O’Brien (1995b, 1997), and is called "Pre-commitment Approach (PCA)." The PCA would require each bank to state the maximum loss exposure for its trading portfolio over a fixed subsequent period. The capital charge for market risk would be equal to this pre-committed maximum loss. If the bank incurs trading losses exceeding the pre-committed level, penalties would be imposed that are proportional to the amount of excess loss. PCA was criticized as being applicable to only well-capitalized banks (see, for instance, Daripa and Varotto (1997)).

2.3 The Model

2.3.1 Model Set-up and Assumptions

There are two main players in this model: "banks" and "the regulator." Although banks are highly regulated and their assets are partly verifiable, there still exists information asymmetry between banks and the regulator. The current Basel Accord defines risk categories based on observable characteristics of bank assets and assigns a higher risk weight to higher risk categories. The final capital requirement for each bank is set based on the risk-weighted assets in the bank’s portfolio. However, these risk categories are very crude and they are very limited in number. Since the regulator can only see the aggregate values of the risk categories, but not the details, banks know the risk details within each risk category better than the regulator does. For instance, all of the commercial loans in the bank’s portfolio are assigned a risk weight of 1, independently of their riskiness. "Regulatory capital arbitrage" (RCA) is the substitution of riskier assets within a risk category for safer assets, with no

\footnote{See Prescott (1997) for a description and Marshall and Venkataraman (1999) for a welfare analysis of the Pre-commitment approach.}
requirement to increase the risk-based capital.

Bank deposits are fully insured by the regulator. Throughout banks pay a fixed-rate premium \( p \) on deposits at the end of each period in return for this insurance.\(^{46}\)

- **Risky Assets:**

Let banks, on the liability side of the balance sheet, have deposits \( (D_t) \) and equity \( (E_t) \) and, on the asset side, have the risky assets \( (A_t) \) at a given time \( t \).\(^{47}\) At time \( t = 0 \), the balance sheet of a bank looks like:

\[
\begin{array}{cc}
\text{Assets} & \text{Liabilities} \\
A_0 & D_0 \\
E_0 & \\
\end{array}
\]

where \( A_0 = E_0 + D_0 \). For simplicity, the risk-free rate of return is normalize to 0 in the model.

Each bank has one category of assets, which can be invested in two different investment opportunities (subcategories): positive NPV “good loans” and zero NPV “risky loans.” Risky loans can be interpreted in many ways: they may be zero NPV, high variance loans, or some securitization of assets, or other derivative instruments that are highly risky. Good loans have higher expected returns than the risky loans, however, risky loans have a strong upside potential, but are likely to cause bankruptcy otherwise. Since the deposit insurance pays for the losses in case of bankruptcy, the risky loans may have higher effective private returns to the banks. The opportu-

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\(^{46}\) As stated by Calem and Rob (1999), after 1993, in addition to the fixed insurance premium, undercapitalized banks are asked to pay an extra premium based on capital ratios and risk-weighted assets. However, banks in this model are assumed to be at least adequately capitalized, since incorporating the possibility of undercapitalization does not add to the scope of the paper.

\(^{47}\) The asset side of the balance sheet could include mandatory reserves \( (C_t) \), which include cash or liquid assets that have risk-free returns. This would only add a constant to our equations, and would not change any of the results. Therefore, for simplicity, I assume that this term is zero.
nity cost of this put option, created by deposit insurance, is the possible loss of the continuation value of the bank.

Good loans have a random gross return, \( r_{L,t} \), with a mean of \( \bar{r}_L \) and a small variance of \( \sigma^2_L \), while risky loans have a random gross return, \( r_{M,t} \), with a mean of \( \bar{r}_M \) and a relatively higher variance of \( \sigma^2_M \). Note that \( \bar{r}_L \) is larger than the gross risk-free rate and \( \bar{r}_M \) is equal to the gross risk-free rate. Hence, good loans are not risk-free, but their variance is much less than the variance of the risky loans.

Banks invest \( \beta_t \) of the total value in good loans and \( 1 - \beta_t \) in risky loans. Let \( r_t \) be the period \( t \) gross return on the total investment. Thus,

\[
r_t = \beta_t r_{L,t} + (1 - \beta_t) r_{M,t}.
\]

Let the sequences of returns, \( r_{L,1}, r_{L,2}, \ldots, r_{L,T} \) and \( r_{M,1}, r_{M,2}, \ldots, r_{M,T} \) be iid, normally distributed and independent.\(^{48}\) Short selling of bank assets is not possible, i.e., \( 0 \leq \beta_t \leq 1 \), since the regulator can observe negative \( \beta_t \). Moreover, in the presence of the deposit insurance guarantee, short selling can increase the risky asset size without limit, allowing the banks to take an infinite amount of risk. (See Gan (2004) for an analysis of banks’ risk taking behavior if there is no limit on their size.)

Given that \( r_{L,t} \sim N(\bar{r}_L, \sigma^2_L) \) and \( r_{M,t} \sim N(\bar{r}_M, \sigma^2_M) \) are independent, \( r_t \) is also normally distributed with mean \( \mu_{r,t} \) and variance \( \sigma^2_{r,t} \), where

\[
\mu_{r,t} = \beta_t \bar{r}_L + (1 - \beta_t) \bar{r}_M
\]

\(^{48}\)Although empirical tests show that returns have fatter tails than implied by normal distribution, the normality assumption is best suited to the additive nature of the problem. Besides, \( r_L \) can be viewed as a convex combination of \( N \) independent safe investment returns for some large \( N \). Then even if each \( r_{L,i} \) can be lognormal, the Central Limit Theorem implies that the distribution of \( r_L = \sum_{i=1}^N r_{L,i} \alpha_i \) converges to a normal distribution.
and
\[ \sigma_{r,t}^2 = \beta_t^2 \sigma_L^2 + (1 - \beta_t)^2 \sigma_M^2. \] (3)

- **Capital Requirement:**

The risk weight of the asset category is assumed to be 1. Note that the risk weight on the commercial loan category is also 1 in the current system. The capital requirement function, \( f(A_0) \), under the current fixed-rate \( (k) \) capital requirements is

\[ f(A_0) = kA_0. \] (4)

Thus,

\[ E_0 \geq kA_0 \] (5)

is required for a bank to be adequately capitalized.49

- **Asset Size:**

Bank size is assumed to be fixed across time. The bank holds the amount invested in risky assets \( (A_0) \) constant over time by distributing the profits to shareholders as dividends. In case of a loss without bankruptcy, the initial shareholders are assumed to subsidize the bank with new capital equal to the loss, and therefore equity is always equal to the initial amount \( E_0 \) while the asset size is equal to \( A_0 \). The model assumes the threshold closing rule. Hence, in case of a bankruptcy (if \( A_0r_t < D_0 \)), the deposit insurer takes over the firm without giving shareholders the option to recapitalize. As discussed in Pelizzon (2001), if shareholders have an option to recapitalize in case of bankruptcy, the probability of bankruptcy will increase because the shareholders will invest in a riskier way, with the supposition that they would put more money in if something unexpectedly bad were to happen.50

49 \( k = 8\% \) under the current capital regulations.
50 In the model, I assume that the threshold for the bankruptcy is zero amount of equity. This
Holding equity fixed at $E_0$ also creates an upper bound for the amount of deposits, $D_0$. Therefore $D_0$ is also constant over time at an amount equal to the maximum allowed by the capital requirements.\footnote{See Stein (1998) for an adverse selection model, in which banks prefer to raise funds through insured deposits rather than equity due to information problems.} Since deposits are riskless assets, their gross return is 1. Then, the amount of dividend distributed at the end of each period is

$$\text{Div}_t = \begin{cases} 0, & A_0 r_t < D_0 \\ (r_t - 1)A_0 - pD_0, & \text{otherwise} \end{cases}, \quad (6)$$

where $r_t$ is the gross return on risky assets, as defined in Eq. (1) and $p$ is the fixed-rate premium per deposits for the deposit insurance.

\subsection*{2.3.2 Banks}

\begin{itemize}
\item \textbf{Value Function of Banks:}
\end{itemize}

Risk-neutral shareholders will have managers maximize the total dividend received by the shareholders. At a given period $t$,

$$\max_s \mathbb{E} \left\{ \sum_{\tau=1}^{\infty} d^\tau \text{Div}_{t+\tau} \right\}$$

where $d$ is the probability that the next period will not be the last period of the bank. Note that this probability is constant since $A_t$ is fixed for all $t$ and $r_t$ is an iid process.\footnote{The probability of continuation, $d$, should not be viewed as an interest-rate discount factor. Indeed, we normalized the gross risk-free return to be 1. By incorporating the probability of having the end-period, we implicitly assumed that the bank has a random lifetime ($< \infty$ w.p. 1.) instead of an infinite one. This assumption is realistic since we cannot expect a bank to survive for an infinite period.}

Since the investment size is assumed to be fixed across time, the bank faces the threshold could be changed to any other positive or negative value without altering the results and the conclusions. Moreover, endogeneizing the optimal threshold choice for the equity holders would not change my results either as long as this choice is kept constant over all $t$, for the model to be technically solvable.
same static problem each period; therefore, the value of the bank and the amount of investment in the good loans, $\beta$, as well as the mean and variance of the gross return on assets ($\mu_r$ and $\sigma_r^2$), should be constant over time. Thus, with the optimum choice of $\beta$, the value of the bank equity at any given period is

$$V(\beta) = E \left\{ \sum_{t=1}^{\infty} d^t (Div_{t+1}) \right\}$$

$$= dPr(A^0_{t+1} > D_0) [E((r_{t+1} - 1)A_0 - pD_0 | A^0_{t+1} > D_0) + V(\beta)].$$

From the Appendix A, the solution for the above problem is given by:

$$V(\beta) = (1 - df(\beta))^{-1} d [g(\beta) + f(\beta) ((\mu_r - 1)A_0 - pD_0)]$$

where

$$f(\beta) = \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right]$$

and

$$g(\beta) = A_0 \sigma_r \exp \left[ \frac{-(D_0 - \mu_r A_0)^2}{2A_0^2 \sigma_r^2} \right].$$

Note that $1 - f(\beta)$ is the probability of bankruptcy. Without loss of generality I assume that the capital requirement is binding for the bank.\textsuperscript{53} Hence,

$$E_0 = kA_0 \iff D_0 = (1 - k)A_0$$

This allows us to rewrite (8) as

$$V(\beta) = (1 - df(\beta))^{-1} d [g(\beta) + f(\beta)(\mu_r - 1 - p(1 - k))A_0]$$

\textsuperscript{53} Holding the asset size fixed, the value of the bank is a decreasing function of its capital requirement $k$. (See the proofs of Propositions 1 and 3 below.) Thus, in equilibrium, the capital requirements bind, and banks do not hold cushion capital.
where

\[ f(\beta) = \Phi \left[ \frac{(k + \mu_r) - 1}{\sigma_r} \right] \]  

(12)

and

\[ g(\beta) = A_0 \frac{\sigma_r}{\sqrt{2\pi}} \exp \left[ \frac{-(1 - (k + \mu_r))^2}{2\sigma_r^2} \right]. \]  

(13)

This can be solved numerically for \( \beta^* = \arg \max V(\beta) \). (See Appendix C.) Figure 2.1 shows how \( V(\beta) \) changes as \( \beta \) and \( \sigma^2_M \) change. Note that, when the variance of the risky loan (\( \sigma^2_M \)) is equal to the variance of the safe loan, the bank optimally sets \( \beta^* = 1 \). That is because the expected return on the safe loan is higher than the expected return on the risky loan while their variances are the same. However, holding other parameters constant, as the variance of the risky loan increases, \( \beta^* \) changes from 1 to 0 since the put option value due to the deposit insurance exceeds the continuation (franchise) value of the bank.

- **Types of Banks:**

There are two types of banks in this model. "G" banks always invest all their assets in good loans (set \( \beta = 1 \)) in order to reduce the probability of bankruptcy and preserve their franchise value. "B" banks do not have the opportunity to invest in good loans, or are better off exploiting the deposit insurance as much as possible, and they always invest all their assets in highly risky loans (set \( \beta = 0 \)). Notice that if both safe and risky investment opportunities are available to all the banks, "G" and "B" types of banks are endogenously determined in the model. Because of the convexity of their value function, banks optimally choose corner solutions: a "G" bank, for which continuation value of the bank is more important than the put option value created by the deposit insurance optimally sets \( \beta = 1 \) while a "B" bank sets \( \beta = 0 \) valuing the put option value, and, therefore, asset return variance more than the continuation value of the bank. Note that these banks could also differ in their quality of lending as well as their potential lending opportunities. Some banks earn relatively more
on their portfolios due to better monitoring and risk management techniques, better
client relationships, better ability to use soft/hard information, or any other expertise
unique to them.

Figure 2.2 illustrates numerical simulations for G and B banks. Holding other pa-
rameters fixed, for instance, a 2% difference in expected return on safe loans (3.75% vs. 1.75%) makes the same bank shift from safe investment ($\beta = 1$) to risky invest-
ment ($\beta = 0$).

The value of the B bank is

$$V(\beta = 0, k) = \left[ 1 - d\Phi \left( \frac{k}{\sigma_M} \right) \right]^{-1} d \left[ A_0 \frac{\sigma_M}{\sqrt{2\pi}} \exp\left( -\frac{(k)^2}{2\sigma_M^2} \right) - \Phi \left( \frac{k}{\sigma_M} \right) (1 - k)pA_0 \right],$$

and the value of the G bank is

$$V(\beta = 1, k) = d \left[ \frac{A_0}{\sqrt{2\pi}} \exp \left[ \frac{-(1-(k+\bar{\tau}_L))^2}{2\sigma_L^2} \right] + \Phi \left( \frac{(k+\bar{\tau}_L)-1}{\sigma_L} \right) (\bar{\tau}_L - 1 - p(1 - k))A_0 \right]\left[ 1 - d\Phi \left( \frac{(k+\bar{\tau}_L)-1}{\sigma_L} \right) \right].$$

Suppose G banks constitute a fraction, $s^G$, while B banks constitute a fraction,
$s^B$, of the population. The regulator knows these fractions in the economy and if
bankrupt banks are continuously replaced by other banks of the same type, these
fractions are, on average, constant across time. Banks are assumed to be symmetric
within types with fixed investment in loans, $A_0$, each period. For the given capital
requirement ratio, the probabilities of bankruptcy for the G banks and the B banks
are, respectively,

$$p_G = (1 - f^G(\beta)) = \Phi \left( \frac{1 - (k + \bar{\tau}_L)}{\sigma_L} \right)$$

and

$$p_B = (1 - f^B(\beta)) = \Phi \left( \frac{-k}{\sigma_M} \right).$$

Thus, $p_G \ll p_B$. 

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2.3.3 The Regulator

In addition to providing deposit insurance to protect small depositors and prevent bank runs, the regulator’s main objectives are as follows:\textsuperscript{54}:

- Maximize the productive capacity of the economy, by making sure that entrepreneurs with good projects will be able to find funding through G banks.

- Enforce a policy function determining capital requirements for the banks in order to prevent bankruptcies and their consequent deadweight losses. This leads to a goal of setting capital requirements at a level which would, given the fixed-rate deposit insurance premiums, covers the expected loss to the regulator in case of default.

The regulator could ensure the solvency of the banks by making them invest only in risk-free securities, but this is socially undesirable since the primary function of a bank, as an intermediary between the lenders and the borrowers, is to provide funding to entrepreneurs with good projects. The flow of entrepreneurial positive NPV project ideas in the economy requires loans from the banks in order to start these projects. Let $\gamma_t$ represent the net return for entrepreneurs on borrowing from G banks. The first objective of the regulator is to maximize the expected value of the following social welfare function at each time period $t$:

$$SW_t = s^G(\gamma_t + r_{L,t} - 1) \frac{E_0}{k^G}$$

where $SW_t$ constitutes the NPV of the investment in good loans during the time period $t$ from both the banks’ and entrepreneurs’ perspectives. The second objective

\textsuperscript{54}Although in the U.S. there exist multiple regulators, such as the Federal Reserve Board, the Federal Deposit Insurance Corporation (FDIC), and the Office of the Comptroller of the Currency (OCC), this paper assumes that all the banking regulation and supervision is done by a single regulator. Separating the functions of the regulator in the model would not add any insight, but only complication.
of the regulator is to set the capital requirement such that, given the fixed-rate deposit insurance premiums, the expected value of providing deposit insurance is at least equal to zero:

\[ E(\text{InsurancePremium}_i^t - \text{Loss}_i^t) \geq 0, \quad i \in G, B. \] (19)

Note that if the regulator has lexicographic preference for maximizing the social welfare function, \( SW_t \), it might be optimal to set the capital requirement for the G banks such that the expected loss to the deposit insurance fund is in fact less than zero. That is because \( SW_t \) is a decreasing function of \( k^G \). But, remember that, although not large, the probability of bankruptcy for the G banks (\( p_G \) as in (16)) is positive. Therefore, if we consider the deadweight losses in case of bankruptcy of G banks as well as decreasing returns to the investment in good loans for the entrepreneurs \( (\gamma_t = c \ln \frac{E_t}{k^G}, \text{where } c \text{ is a constant}) \), the amount of optimal expected loss to the regulator of providing the deposit insurance to the G banks will be endogenously determined.\(^{55}\) For simplicity, I assume that the regulator sets the capital requirement for the G banks such that its expected loss of providing deposit insurance is equal to zero. This might be interpreted as a long-run equilibrium assumption, where marginal return on good loans is expected to be zero.

\( E(\text{InsurancePremium}_i^t - \text{Loss}_i^t) = 0 \) would imply the following constraints on the capital requirements of the G and the B banks (see Appendix A.2 for their derivation).

\[ p(1-k^G) + (k^G + \bar{r}_L - 1)\Phi\left[ \frac{1 - (k^G + \bar{r}_L)}{\sigma_L} \right] - \frac{\sigma_L}{\sqrt{2\pi}} \exp\left[ \frac{-(1 - (k^G + \bar{r}_L))^2}{2\sigma_L^2} \right] = 0 \] (20)

\[ p(1-k^B) + k^B \Phi\left[ -\frac{k^B}{\sigma_M} \right] - \frac{\sigma_M}{\sqrt{2\pi}} \exp\left[ \frac{-(k^B)^2}{2\sigma_M^2} \right] = 0 \] (21)

\(^{55}\)If the good loans in the economy is in limited supply, then net return to the G bank, \( r_{L,t} - 1 \), would also be decreasing in total size of the assets, \( \frac{E_t}{k^G} \).
where $k^G$ and $k^B$ are the amounts of capital that make the deposit insurance system break even in case of default within that time period for the G and the B banks, respectively, and $p$ is the fixed-rate deposit insurance premium paid by the banks on insured deposits. In other words, $k^G$ and $k^B$ are the first-best values of the capital requirement for the two types of banks in this model. Figure 2.3 plots equations (20) and (21). Note that $k^B$ is significantly larger than $k^G$.

Capital requirements create an upper bound on the asset size of the banks. First-best values for the maximum allowable sizes of the G banks and B banks are

$$A^G_0 = \frac{E_0}{k^G}$$  \hfill (22) \\
and

$$A^B_0 = \frac{E_0}{k^B},$$  \hfill (23) \\
where $A^G_0 > A^B_0$. Note that, holding equity fixed, the sizes of the banks decrease as their capital requirements increase.

2.3.4 Pooling Equilibrium

Under asymmetric information, first-best values of the capital requirements are not feasible because B banks have an incentive to act as if they were G banks. Since the regulator cannot differentiate good banks from bad banks and only knows their fractions in the economy, as in the current fixed-rate capital requirement system, the regulator sets the required amount of capital for each bank (or asset category) equal to

$$k^* = w_G k^G + w_B k^B,$$  \hfill (24)

where $k^G < k^* < k^B$ and $w_G$ and $w_B$ are the weights. These weights are functions of $s^G$ and $s^B$, and they also depend on the demand for the good loans in the economy.
Proposition 1 If the regulator cannot differentiate B banks from G banks, B banks always pool with G banks in order to have the fixed-rate (\(k^*\)) capital requirement.

Proof. See Appendix B.1.

The current regulations make the B banks better off by reducing the required amount of capital for them and consequently increasing the upper bound on their sizes while making the G banks worse off by increasing their capital requirement and shrinking their sizes. Since the reduction in the upper bound on the sizes of the G banks reduces loans to good entrepreneurs, and the increase in the size of B banks means higher probable bankruptcy costs, the economy is worse off in the presence of the information asymmetry between the banks and the regulator.

Corollary 2 The social welfare function is expected to decrease as the economy switches from the first-best capital requirements to the pooling equilibrium capital requirement, \(k^*\).

Proof. See Appendix B.2.

As the capital requirement for the G banks increases, holding equity constant, their sizes, and hence, good loans to entrepreneurs, decrease. Therefore, \(E(SW_t)\) decreases under the pooling equilibrium.

Moreover, under the pooling equilibrium,

\[ p(1 - k^*) + s^G \left[ \alpha \Phi \left( \frac{-\alpha}{\sigma_L} - \frac{\sigma_L}{\sqrt{2\pi}} \exp \left( \frac{-(\alpha)^2}{2\sigma_L^2} \right) \right] + s^B \left[ k^B \Phi \left( -\frac{k^*}{\sigma_M} - \frac{\sigma_M}{\sqrt{2\pi}} \exp \left( \frac{-(k^*)^2}{2\sigma_M^2} \right) \right] = 0 \]

where \(\alpha = k^* + \bar{r}_L - 1\).
\[ E(\text{Insurance Premium}^B_t - \text{Loss}^B_t) < 0, \]

which implies that the expected value of providing deposit insurance to the B banks is, on average, less than zero. In other words, if both types of banks are subject to the same capital requirement, \( k^* \), the condition to satisfy a prime objective of the regulator - to set expected value of providing deposit insurance to B banks equal to at least zero - never holds. That is because, holding equity constant, \( A_0 \) is a declining function of \( k \) and

\[
\frac{d}{dk}(p_B) = \frac{d}{dk}(1 - f^B(\beta)) = -\frac{1}{\sigma_M} \phi \left( \frac{-k}{\sigma_M} \right) < 0,
\]

where \( p_B \) is the probability of bankruptcy for the B banks.

In other words, due to the decrease in their capital requirement, both the sizes and the bankruptcy probabilities of the B banks increase under the pooling equilibrium. On the other hand, the increase in capital requirement from \( k^G \) to \( k^* \) for the G banks reduce their probability of bankruptcy, making the expected value of providing deposit insurance to the safe banks positive for the regulator. However, when compared to the increase in the probability of bankruptcy for B banks, this effect is minor since G banks already have a much lower probability of going bankrupt compared to the B banks (see equations (16) and (17) above). Therefore, expected losses due to bankruptcy increase in the pooling equilibrium.

To sum up, the current system creates an inefficient pooling equilibrium where G and B banks are exposed to the same capital requirement, decreasing the sizes of the safe banks while increasing both the sizes and the bankruptcy probabilities of the risky banks in the economy.
2.4 BASEL II

The new Capital Accord, Basel II, is an attempt to be more effective in regulating banks’ risky investments. A major change proposed by Basel II regulations is the introduction of an option for banks to choose between two approaches in calculating their asset risk.\(^5\)\(^7\) These two options, the "Standardized Approach" and the “Internal Ratings-based (IRB) Approach,” are already described in the introduction. If a bank chooses to use the IRB Approach and if this decision is approved by the supervisors after some examination, the regulatory capital that it has to hold against a credit exposure will be determined by a function of the credit risk of this exposure. Under this approach, a bank’s internal risk measurement systems will assign probabilities of default (PDs) for the risky assets. Moreover, the risk assessments by the bank will also include the loss given (LGD) and the exposure at default (EAD). Based on these estimates, the regulator enforces the capital requirement function that will set the regulatory capital for the bank.\(^5\)\(^8\) Jackson (2002) gives a simplified version of the capital requirement functions as follows:

\[
k^{IRB} = LGD \times \Phi \left[ \frac{\Phi^{-1}(PD) + \rho^{1/2} \Phi^{-1}(C)}{\sqrt{1 - \rho}} \right] \times EAD,
\]

\(^5\)\(^7\)There are three pillars of Basel II: capital adequacy requirements, supervisory review, and market discipline. This model does not incorporate the third pillar since it is not related to the regulatory arbitrage problem. See Decamps, Rochet, and Roger (2004) for a continuous-time model of market discipline and its effects on banks’ behavior and capital requirements. Moreover, this chapter concentrates on the Accord as prepared by the Basel Committee of the Bank of International Settlements (BIS). See Gordy(2003) for its theoretical foundations. Different countries could be implementing it with their own modifications. In a later section, the U.S. case will be discussed in detail.

\(^5\)\(^8\)In fact, there are two variants of IRB; one is the "Advanced IRB Approach" that was already introduced. Second one is the "Foundation IRB Approach", where the bank determines only the probability of default (PD) for the risky assets, and the regulator determines other parameters (LGD, EAD) as well as the capital requirement function. For this paper’s purpose, there is no need to differentiate between these two approaches. Therefore, I will use the word "IRB approach", referring to any of the two. LGD measures the proportion of exposure that will be lost if a default occurs; EAD for loan commitments measures the amount of the facility that is likely to be drawn if a default occurs.
where $\Phi$ is the normal distribution cdf, $C$ is the confidence interval, and $\rho$ is the asset correlation that is set by the supervisory committee. (See Basel Committee on Banking Supervision (2003) for the capital requirement function, including maturity of the exposure and the formula defining $\rho$.)

Switching to the IRB approach will be costly for the banks because of the high costs of setting up a sound internal risk assessment infrastructure that can be approved by the regulator. The criteria for getting this approval are quite demanding. As explained in Gallati (2003), the bank must have a sufficient number of staff familiar with complex models not only in the area of trading, but also risk control, internal auditing, and back office functions. The bank must also possess an adequate electronic data processing infrastructure. The following quotation is from Financial Times of March 2, 2004, with the title “HSBC spells out cost of global regulation,” representative of the banks’ complaints about these high set-up costs:

HSBC has become the first bank to spell out the mounting cost of regulation round the world, saying that compliance with different rules and regimes cost it about $400m last year. HSBC, which operates in 79 countries and is overseen by about 370 regulators, expects the burden to rise as new regulations, such as Basel II rules on bank capital, come into force...The Basel II rules will require banks to invest heavily in new systems for assessing credit and operational risk before 2007...

Another essential feature of the IRB approach is the “back-testing” by the supervisors. Based on the past years’ observations, supervisors check the accuracy of the estimates reported by the banks. However, Ward (2002a) argues that relying on banks’ risk estimates is not incentive-compatible unless those risk estimates

59 A similar formula to determine capital requirement due to market risk is the following: $k_{\text{market}}^{IRB} = 3VaR + constant$, where VaR is the statistical measure Value-at-Risk, which gives the maximum loss that can occur over a given time period, at a given confidence interval, due to exposure to market risk. The IRB Approach for market risk was introduced in the 1997 amendment to the current Accord, and the proposed Basel II rules extend this approach to credit and operational risks.
are backed up by other safety measures that penalize excessive risk taking since the back-tests by supervisors do not have the power to distinguish good risk estimating models from bad ones, banks have incentives to manipulate the models to have lower risk estimates, and securitization will again be rewarded. Moreover, as pointed out by Rochet (1999), the practical implementation of risk models raises concerns as well. For instance, all possible estimation methods (e.g., historical simulations, first-order Gaussian approximations, or Monte Carlo or bootstrap methods) have some drawbacks: the stationary assumption of historical simulations is empirically rejected; returns empirically have fatter tails than their Gaussian approximations; etc.60 Danielsson et al. (2001), criticizing the Basel II Accord, also emphasizes that statistical models used for forecasting risk have been proven to give inconsistent and biased forecasts, and their performance is very sensitive to the specification of parameters such as estimation horizon. Therefore, when internal models are used to determine capital requirements, banks will have incentives to manipulate the internal risk assessment models to have lower risk estimates, and risk shifting will again be rewarded.

2.4.1 Basel II Model Set-up and Assumptions

We have the same setup as before; however, banks now have an option to choose from the old system of fixed-rate capital requirement (k*) and their own internal risk assessment system (only after getting approval from the supervisor) in order to determine how much capital to hold. Main characteristics of the model are listed below.

- **Capital Requirements under the IRB Approach:**

  Under the IRB approach, the regulator sets the capital requirement, \( k^{IRB} \), based on the risk estimates produced by the banks’ internal risk assessment models. For the

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60See also Kupiec and O'Brien (1995a) for a review and critique of the internal models approach.
G banks, this capital requirement, $k^{IRB}$, would be equal to $k^G$, which is the amount of capital that makes expected loss to the regulator providing deposit insurance equal to zero (as defined in equation (20)). If $k^G$ were higher than $k^{IRB}$, the regulator would like to enforce $k^G$; on the other hand, if it were lower, the bank would prefer to report $k^G$ instead. Thus, G banks will enjoy a lower capital requirement than the pooling equilibrium capital requirement, $k^*$, if they adopt the IRB approach.

For a B bank, the IRB approach would require a higher capital requirement (for instance $k^B$, as defined in equation (21)) than the one in the standardized approach. Note that since a similar information asymmetry between the banks and the regulator still exists under the IRB approach and back-tests do not work efficiently, any B bank can has incentives to switch to the IRB approach in order to pretend to be a G bank, with its lower capital requirements and higher size.

- **Supervision under the IRB Approach:**

Banks that choose to use their internal risk models will be under close supervision. We assume that there exists some probability $\theta$ that any B bank, switching to the IRB approach and pretending to be a G bank will be caught misreporting own risk estimates by the regulator. When such a bank is caught, it will be penalized to have $k^B$ as the capital requirement for all periods afterwards.

In addition, like a G bank, a B bank will have to pay a per unit asset size of $c_s$ when it is subject to supervision.

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61 It is worth mentioning again that $k^G$ is the upper bound on the capital requirement that the G banks will be obliged to hold. Given that, holding the size of the equity constant, the social welfare function is decreasing in $k^G$, it might not be optimal for the regulator to set the capital requirement such that deposit insurance system breaks even. The optimal capital ratio will be determined by the trade-off between the deadweight cost due to bankruptcy of G banks and the marginal increase in social welfare function due to increase in size of the G banks.

62 As the ratio of capital to deposits increases, the incentives of the shareholders to gamble decrease. Therefore, the increase in the capital requirement to the first-best level can make some B banks switch to investing safely if they have alternative safer investment opportunities. Moreover, this model simply concentrates on only a single asset-risk category, and there might be some other safe investments of the banks that correspond to some other asset-risk categories. That is because the regulator is not better off closing the B banks as they are caught.
Set-up Costs under the IRB Approach:

A reasonable assumption for the set-up costs for the IRB approach is that they will be much higher for B banks than G banks. Since G banks might already have these risk measurement systems or similar ones set up in order to be able to choose more prudent investments, their set-up costs under the IRB approach are less than those for B banks. One can also argue that since the average life-time of a G bank is much longer than a B bank because of the difference in their respective bankruptcy probabilities, this set-up cost per year within the life-time is much smaller for the G banks than for the B banks. Formally, the fixed set-up cost is \( C_F^B \) for the B banks, is \( C_F^G \) for the G types and \( C_F^G \ll C_F^B \). For simplicity, \( C_F^G = 0 \) in the analyses.

**Proposition 3** Every G bank will adopt the "IRB approach," and will hold their first-best capital amount, \( k^G \).

**Proof.** See Appendix B.3. ■

The G banks are always better off identifying themselves to the regulator by adopting the IRB approach, so that they can hold less capital.

**Corollary 4** Neither a pooling equilibrium, in which both types of banks choose to continue using the "Standardized approach," nor a separating equilibrium, in which G banks choose to continue using the "Standardized approach" and B banks adopt the "IRB approach," are possible.

**Proof.** Following Proposition 3, since G banks will always switch to the IRB approach, the proof of the corollary is trivial. ■

The decision of B banks depends on the relative benefits and costs of switching to the IRB approach. Will B banks always have an incentive to switch to the new system? The next section will address this question.
2.4.2 Separating Equilibrium Under Basel II

Given that all the G banks will adopt the IRB approach, B banks have two alternatives: either stay in the old system and identify themselves to the regulator or try to adopt the IRB approach and pretend to be G banks. The capital requirement in the standardized approach, \( k^* \), is higher now because all the banks that stay out of the IRB approach will be B banks. The regulator will increase \( k^* \) to \( k_B \), which sets the expected loss to the regulator from providing deposit insurance to the B banks equal to zero.

A separating equilibrium, in which B banks stay in the standardized approach and are required to hold \( k_B \) amount of capital while G banks switch to the IRB approach is possible if the probability of being caught (\( \theta \)) or the cost of switching to the IRB approach (\( C_{B}^{IRB} \)) is high enough:

\[
V^{IRB}(\beta = 0, k^G, C_B^{IRB}) - C_F^{IRB} < V(\beta = 0, k_B),
\]

where \( V^{IRB}(\beta = 0, k^G, C_B^{IRB}) \) is the value of the B bank, pretending to be a G bank under the IRB approach, with \( k = k^G \) and supervision cost, \( C_B^S; C_F^B \) are the fixed setup costs; and \( V(\beta = 0, k_B) \) is the value of the B bank, as given in equation (14) with \( k = k_B \) in the old standardized system. It can be shown that \( V^{IRB}(\beta = 0, k^G, C_B^{IRB}) \) is equal to

\[
d \left[ \frac{\theta k^G \sigma_M}{\sqrt{2 \pi}} \exp \left( -\frac{\left( k^G - \theta \right)^2}{2 \sigma_M^2} \right) + \Phi \left( \frac{k^G}{\sigma_M} \right) \left[ \theta V(\beta = 0, k_B) - (c_a + (1 - k^G) p) \frac{\theta}{k_B} \right] \right] \\
\left[ (1 - d)(1 - \theta) \Phi \left( \frac{k^G}{\sigma_M} \right) \right].
\]

See Appendix A.3 for the derivation.

However, inequality (26) is unlikely to hold because, given the criticisms of the efficiency of supervision and back-testing, \( \theta \) is not expected to be very high. For \( \theta < 1 \), B banks will switch to the IRB regime with its lower capital requirements.
by pretending to be a G bank, as long as the set-up costs are not sufficiently high. This incentive is also driven by the fact that the required capital ratio in the old standardized approach \((k^B)\) is the same as the penalty capital ratio that the B bank would be obliged to hold if caught. Hence, the following inequality holds if \(C^B_F\) or \(\theta\) is sufficiently low:

\[
V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_F > V(\beta = 0, k^B).
\] (28)

Therefore, it is not in the interest of the regulator to increase the capital requirement for the standardized approach up to \(k^B\) since the aim of the regulator is the separation of G banks from B banks so that G banks’ sizes and consequently good loans going to the entrepreneurs are not rationed. On the other hand, the goal of the regulator is to set the capital requirement for the B banks as high as possible so as to both reduce the costs in case of bankruptcy and induce a switch to safe investment by them. Because the first-best values of capital requirements are not possible to enforce by making all types of banks switch to the IRB approach, the regulator would prefer giving some incentives to B banks in order to prevent the IRB approach from being an inefficient pooling equilibrium.

If there exists a \(k^*_{\text{new}}\) that is higher than the current capital requirement \((k^*)\) but lower than the first-best for the B banks \((k^B)\), such that for the given \(C^B_S\) and \(\theta\), a B bank is made indifferent between trying to adopt the IRB approach and staying in the old system, the regulator can sustain a separating equilibrium by setting the capital requirement for the standardized approach less than \(k^*_{\text{new}}\). Proposition 5 below defines this separating equilibrium.

**Proposition 5** Given the supervision and set-up costs for the banks and the probability of being caught as a B bank pretending to a G bank under the IRB approach, there exists a \(k^*_{\text{new}}\) such that the following separating equilibrium exists:
1. G banks switch to the IRB approach, and their capital requirement is $k^G$.

2. B banks stay in the old system of the standardized approach and their capital requirement will be $k^*_{new} - \varepsilon$, where $k^G < k^*_{new} < k^B$ and the following equation is satisfied.

$$V^{IRB}(\beta = 0, k^G, C^B_P) - C^B_P = V(\beta = 0, k^*_{new}).$$

**Proof.** See Appendix B.4. ■

The following corollary shows that, compared to the current system, the regulator will be better off if the separating equilibrium, in which both G and B banks are identified by the regulator and G banks are rewarded with the decrease in their capital requirements, can be sustained.\(^{63}\)

**Corollary 6** Compared to the pooling equilibrium under the standardized approach (as described in Proposition 1), the separating equilibrium, in which all the G banks adopt the IRB approach and all the B banks stay in the standardized approach (as described in Proposition 3), increases the social welfare function.

**Proof.** See Appendix B.5. ■

The corollary states that social welfare is maximized because the sizes of the safe banks, and consequently the sizes of the good loans to the entrepreneurs, increase when the G banks adopt the IRB approach.

\(^{63}\)A reasonable question to ask here is why the regulator does not wait for a few periods and identify the B banks, and then close them. There are a few answers to this question. First, among the B type banks, there might be some BG types, which could create safe investment opportunities for themselves and for which a high enough increase in capital requirements might cause their investment decision to shift to these safe assets. If $k^*_{new} > k^*$, these BG types might start investing safely because as the share of their own capital within the portfolio, which can be lost, increases, their incentives to gamble decrease. As stated in Furlong and Keeley (1989), low levels of capital increase banks’ incentives to take risks and this is one of the main motives for the capital adequacy regulation. Second, there exists continuous replacement of bankrupt firms; in other words, each period there could be some new B banks entering the economy. Thus, such a penalty would destroy the separating equilibrium for the incoming B banks. Third, this is a very simplified model of regulatory capital arbitrage, concentrating only in a single asset-risk category. There could be some other investments of the same bank belonging to the risk-free category or other types of safe investments.
On the other hand, one of the main objectives of the regulator is to set the capital requirements such that the expected loss of providing the deposit insurance is at least equal to zero. In the pooling equilibrium under both the IRB approach and the standardized approach, this constraint is not satisfied for the B banks since they are required to hold less capital than the first-best value. In this way, the sizes and, more importantly, the probability of bankruptcy of the B banks become larger than they should be. Therefore, the increase in capital requirements for the B banks under the separating equilibrium of Basel II will better align the regulatory capital of the B banks with their true portfolio risks and reduce the probability of default as well as the loss given default.

This statement is true only under certain conditions, though. Since, with probability $\theta$, B banks are caught misreporting the risk estimates under the IRB approach and thereafter penalized by being obliged to hold their first-best capital requirements, the regulator will be better off by giving incentives ($k_{new}^* - \epsilon$ instead of $k^B$) to the B banks to stay in the standardized approach only if $\theta$ is not high enough. Moreover, when compared to the pooling equilibrium under the standardized approach, the regulator will certainly be better off under the Basel II separating equilibrium if $k_{new}^* - \epsilon > k^*$. However, if $k_{new}^* - \epsilon < k^*$, in order to conclude that the regulator would still be better off, we need to show that the increase in the social welfare function due to increase in sizes of the G banks is larger than the decrease in value due to increase in the sizes and bankruptcy probabilities of the B banks when they have $k_{new}^* - \epsilon$ instead of $k^*$ as the capital requirement.

Using the IRB approach would also be a better way for G banks to align regulatory measures of risk with the true economic risks of their portfolio. Securitization and credit derivatives could be used for diversification of portfolio risk and reducing the costs of debt financing. In other words, these instruments can be used to reduce underlying economic risk instead of exploiting deposit insurance, as long as they are
within efficiency limits. Therefore, it is good to separate the banks that use risky instruments within efficiency limits from banks that use them in order to create discrepancies between economic risk and its regulatory measure.

The empirical question is whether the Basel II separating equilibrium described in Proposition 3 can be sustained for reasonable values of the probability of being caught ($\theta$) and the sunk-cost of switching to IRB for B banks ($C^B_F$). In the numerical simulations, $k^*_{\text{new}} > k^*$ exists only for really high values of $C^B_F$ or $\theta$. Given the set-up cost, differences between G and B banks should be sufficiently observable and the back-testing and supervision must sufficiently be efficient. This is the main regulatory challenge.

2.4.3 Implementation of Basel II Rules in the U.S.

Although the U.S. is the most influential member of the Basel Committee on Banking Supervision, the implementation of the Basel II rules in the U.S. will be slightly different from the proposed Accord. (See, for instance, Hannan and Pilloff (2004) for discussion and references, and, for an overview, the "U.S. Implementation of Basel II: An Overview (2003).") According to the current proposal, banks of at least $250$ billion asset size or of at least $10$ billion on-balance-sheet foreign exposure will be obliged to adopt the IRB approach (in fact, the Advanced IRB approach; see footnote 58 for the definition). These criteria include about the ten largest banking firms in the U.S. Other banks will be given the option to switch to the IRB approach as long as they have sound enough risk assessment infrastructures. The ten or so largest banks and also the ones that later become eligible to adopt the IRB approach will, most probably, be subject to lower capital requirements than under the standardized approach. Among the objectives of the revisions to the Basel Accord are listed the following: "develop a measure of capital that is more risk sensitive than the current approach and better suited to the complex activities of the international banks"
and also "encourage improvements in risk management and enhance internal assessments of capital adequacy." (See the "U.S. Implementation of Basel II: An Overview (2003).") The banks that are obliged to adopt the IRB approach might have been chosen by using their sizes and foreign exposures as indicators of their prudence. However, a more important reason could be that, as expressed by the regulators, these banks form the core of the financial stability in the U.S., and making them invest in their risk measurement systems is therefore essential.

Within the U.S. implementation of the Basel II, the model set-up of this chapter is more applicable to all U.S. banks excluding the ten or so largest banks because in the model, all banks are assumed to have an option to stay in the standardized approach. However, the model can be easily modified such that the regulator might use some exogenous factors such as banks’ asset sizes as indicators of the prudence of their investments. Such a modification will not alter the conclusions of this chapter since, in the current model, these largest banks are expected to be investing safely and switching to the IRB approach due to their very high continuation value.

### 2.5 Conclusion

This chapter contributes to the ongoing discussions about the Basel II Accord, and its model provides some empirical predictions which can be tested after the implementation of these new rules. In particular, this study provides an understanding of banks’ risk-shifting incentives, derived from the divergences between true economic risks and their regulatory counterparts, under the current capital regulations. These incentives create an inefficient pooling equilibrium, in which banks investing in an unduly risky way pretend to be investing safely in order to have a lower capital requirement. The chapter examines whether the proposed "Basel II" regulatory system would be more efficient and effective in dealing with these incentives. The IRB Approach of Basel II is an attempt to use banks’ own internal risk estimates in setting regulatory capital
requirements. I show that this approach can instead be interpreted as an attempt to create a separating equilibrium, in which safe banks adopt the IRB approach while the banks that do not invest prudently stay with the old standardized approach. This will be a signaling equilibrium, in which

- by choosing to use their own internal risk assessment systems, safe banks identify themselves to the regulator and are rewarded by a lower capital requirement than the one in the pooling equilibrium;

- banks that do not invest prudently will have some incentives to stay in the old system instead of using their own internal risk assessment models and pretending to be safe banks because adopting the IRB approach creates high set-up and supervision costs for them;

- and the regulator might be better off setting the capital requirement of the standardized approach to be less than the first-best capital ratios of risky banks in order to give them enough incentives to stay in the standardized approach.

In interpreting the changes coming with Basel II, the objective of the regulator while implementing the new rules is critical. If the regulator’s only aim is to make all the banks invest in their risk assessment systems, then the regulator might aim to provide incentives to create a pooling equilibrium under the IRB approach for both safe and risky banks. If, additionally, Basel II attempts to solve the regulatory capital arbitrage problem of the current capital adequacy rules, the regulator must create incentives for the risky banks to stay in the standardized approach unless adopting the IRB approach will make them invest more prudently. Under the IRB approach, risky banks will invest safely only if the supervision system is effective enough to considerably reduce the information asymmetry between the banks and the regulator. However, given that the supervision system is not expected to be effective enough, separating equilibrium can only be sustained by giving some incentives to
the excessively risk-taking banks not to opt into the new IRB approach, by setting their capital requirements in the standardized approach lower than their first-best.

The planned U.S. implementation of Basel II uses the size or foreign exposure of the banks as the main indicator for their prudence, and obliges the ten or so largest U.S. banks to adopt the IRB approach. The main reason for this decision is stated as to make these banks improve their risk assessment systems since these banks constitute the core of the U.S. banking system. However, what about the rest of the banks? Will the implementation of Basel II in the U.S. be effective in preventing risk-shifting incentives of the banks other than the largest ten or so? Will the set-up costs for the required infrastructure to meet the criteria of the supervisors be low enough for the smaller-sized but prudent banks that they can adopt the IRB approach instead of staying in the inefficient pooling equilibrium of the standardized approach? We must wait for the implementation of Basel II to be able to empirically answer these questions.
References


2.6 Appendix A

2.6.1 Appendix A.1: Derivation of $V(\beta)$, Value of the Bank

\[
V(\beta) = E \left\{ \sum_{\tau=1}^{\infty} d^{\tau}(Div_{\tau+\tau}) \right\}
\]
\[
= E \left\{ dDiv_{\tau+1} + \sum_{\tau=2}^{\infty} d^{\tau}(Div_{\tau+\tau}) \right\}
\]
\[
= dPr(A_0r_{t+1} > D_0) [E [(r_{t+1} - 1)A_0 - pD_0 | A_0r_{t+1} > D_0] + V(\beta)],
\]

where

\[
Pr [A_0r_{t+1} > D_0] = \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right]
\]

and

\[
E [A_0(r_{t+1} - 1) | A_0r_{t+1} > D_0] = E [A_0(r_{t+1} - \mu_r) | A_0(r_{t+1} - \mu_r) > D_0 - \mu_r A_0] + (\mu_r - 1)A_0 - pD_0.
\]

Let $z = A_0(r_{t+1} - \mu_r)$. Since $r_{t+1} \sim N(\mu_r, \sigma_r^2)$ and $z \sim N(0, \sigma_z^2)$ where $\sigma_z^2 = A_0 \sigma_r^2$,

\[
E [A_0(r_{t+1} - 1) | A_0r_{t+1} > D_0] = \int_{\sigma_z^2}^{\infty} \frac{1}{\sqrt{2\pi} \sigma_z} z \exp \left[ \frac{-z^2}{2\sigma_z^2} \right] \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right] + (\mu_r - 1)A_0 - pD_0
\]

\[
= \frac{A_0 \sigma_z}{\sqrt{2\pi}} \exp \left[ \frac{-(D_0 - \mu_r A_0)^2}{2A_0 \sigma_z^2} \right] \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right] + (\mu_r - 1)A_0 - pD_0
\]

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Thus,

\[ V(\beta) = d \frac{\sigma_r}{\sqrt{2\pi}} A_0 \exp \left[ \frac{-(D_0 - \mu_r A_0)^2}{2 A_0^2 \sigma_r^2} \right] + d \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right] [V(\beta) + (\mu_r - 1) A_0 - p D_0] \]

If

\[ f(\beta) = \Phi \left[ \frac{\mu_r A_0 - D_0}{A_0 \sigma_r} \right] \text{ and } g(\beta) = A_0 \frac{\sigma_r}{\sqrt{2\pi}} \exp \left[ \frac{-(D_0 - \mu_r A_0)^2}{2 A_0^2 \sigma_r^2} \right], \]

then the value of the bank will be

\[ V(\beta) = (1 - df(\beta))^{-1} d [g(\beta) + f(\beta)(\mu_r - 1) A_0 - p D_0] \]

and the maximum is found at \( \beta^* \) where

\[ V(\beta^*) = \max_{\beta} \left\{ (1 - df(\beta))^{-1} d [g(\beta) + f(\beta)(\mu_r - 1) A_0 - p D_0] \right\} \]

2.6.2 Appendix A.2: Derivation of \( k^G \) and \( k^B \), First-Best Values for the Capital Requirements

Given the fixed-rate \( p \) insurance premiums, the first-best values are obtained by setting the expected loss of providing deposit insurance equal to zero as follows.

\[ E(\text{InsurancePremium}_i - \text{Loss}_i) = 0 \]

\[ p D_0^i + \Pr(\text{Default}_i) E(\text{Loss}_i | \text{Default}_i) = 0, \]

where \( i \in \{G, B\} \). For the corresponding parameters of G and B banks,

\[ \Pr(\text{Default}) = \Pr[A_0 r_t < D_0] = \Pr[r_t < 1 - k] = \Phi \left[ \frac{1 - k - \mu_r}{\sigma_r} \right], \]

\[ (29) \]
where (29) uses the assumption that capital requirements are binding for the banks (i.e., $E_o = kA_o$).

\[
E(\text{Loss}|\text{Default}) = E[A_0 r_t - D_0|A_0 r_t < D_0] \\
= E[A_0(r_t - k - 1)|A_0 r_t < A_0(1 - k)] \\
= E[A_0(r_t - \mu_r)|A_0(r_t - \mu_r) < A_0(1 - k - \mu_r)]
\]

With a similar derivation to the previous section,

\[
E(\text{Loss}|\text{Default}) = -\frac{A_o \sigma_r \exp \left[ -\frac{(1-k-\mu_r)^2}{2\sigma_r^2} \right]}{\Phi \left[ \frac{1-k-\mu_r}{\sigma_r} \right]} + A_0(\mu_r + k - 1).
\]

Thus, plugging $D_0 = (1 - k)A_0$ we get

\[
p(1-k)^G + (k^G + \bar{\gamma}_L - 1) \Phi \left[ \frac{1 - (k^G + \bar{\gamma}_L)}{\sigma_L} \right] - \frac{\sigma_L}{\sqrt{2\pi}} \exp \left[ \frac{-(1 - (k^G + \bar{\gamma}_L))^2}{2\sigma_L^2} \right] = 0 \quad (30)
\]

and hence,

\[
p(1-k)^B + k^B \Phi \left[ \frac{-k^B}{\sigma_M} \right] - \frac{\sigma_M}{\sqrt{2\pi}} \exp \left[ \frac{-{(k^B)}^2}{2\sigma_M^2} \right] = 0, \quad (31)
\]

completing the derivation.
2.6.3 Appendix A.3: Derivation of $V^{IRB}(\beta = 0, k^G, C_S)$, Value of a "B" Bank under the IRB Approach

The value of a B bank after switching to the IRB approach is

$$V^{IRB}(\beta = 0, k^G, C_S) = E \left\{ \sum_{\tau=1}^{\infty} d^\tau (Div_{t+\tau}) \right\}$$

$$= dDiv_{t+1} + (1 - \theta)V^{IRB}(\beta = 0, k^G, C_S) + \theta V(\beta = 0, k^B)$$

$$= d Pr \left[ A_0 r_{t+1} + k^G A_0 > D_0 \right]$$

$$\cdot \left\{ E \left[ A_0 (r_{t+1} - p - 1) | A_0 r_{t+1} + k^G A_0 > D_0 \right] \right\}$$

$$+ (1 - \theta)V^{IRB}(\beta = 0, k^G, C_S) + \theta V(\beta = 0, k^B) \right\} \cdot (32)$$

When the capital requirement is binding, we can rewrite (32) replacing $A_0$ with $\frac{E_0}{k^G}$ and $D_0$ with $(1 - k)\frac{E_0}{k^G}$

$$V^{IRB}(\beta = 0, k^G, C_S) = d \left[ \frac{E_0 \sigma_M}{k^G \sqrt{2\pi}} \left[ \exp\left(\frac{-(k^G)^2}{2\sigma_M^2}\right) + \Phi\left(\frac{k^G}{\sigma_M}\right) \right] \right.$$

$$\cdot \left. \left[ (1 - \theta)V^{IRB}(\beta = 0, k^G, C_S) + \theta V(\beta = 0, k^B) - (c + p)\frac{E_0}{k^G} \right] \right\}.$$

With further simplification, we get

$$V^{IRB}(\beta = 0, k^G, C_S) = d \left[ \frac{E_0 \sigma_M}{k^G \sqrt{2\pi}} \exp\left(\frac{-(k^G)^2}{2\sigma_M^2}\right) + \Phi\left(\frac{k^G}{\sigma_M}\right) \left[ \theta V(\beta = 0, k^B) - (c + (1 - k^G)p)\frac{E_0}{k^G} \right] \right.$$

$$\cdot \left. \left[ (1 - d)(1 - \theta)\Phi\left(\frac{k^G}{\sigma_M}\right) \right] \right\}.$$

2.7 Appendix B

2.7.1 Appendix B.1: Proof of Proposition 1

Proposition 1: If the regulator cannot differentiate B banks from G banks, B banks always pool with G banks in order to have the fixed-rate ($k^*$) capital requirement.
Since the regulator can not differentiate B banks from the G banks, the only way for the B banks to choose a higher capital requirement than \( k^* \) would be their voluntary incentive to do so. We can easily show that, given the natural upper bound that the capital requirement creates on size, the maximized value of the B banks \( (V(\beta^* = 0, k)) \) is a declining function of \( k \).\(^{64}\) Thus,

\[
\frac{d}{dk}(V(\beta^* = 0, k) < 0, \forall k.
\]

Let \( E_0 \) be the constant value for the initial amount of equity, \( k \) be the required capital ratio, \( d \) be the discount factor, \( \sigma_M \) be the variance of the return on risky loans, and \( \Phi \) and \( \phi \) be the normal cdf and pdf, respectively. Note that we set \( p = 0 \) in this analysis just for simplicity. The result does not change for \( p > 0 \) also. We have

\[
V(\beta^* = 0, k) = \left[(1 - d\Phi \left(\frac{k}{\sigma_M}\right))\right]^{-d} \left[\frac{E_0 \sigma_M}{k \sqrt{2\pi}} \left[\exp\left(\frac{- (k)^2}{2\sigma_M^2}\right)\right]\right].
\]

Then \( \frac{d}{dk}V(\beta^* = 0, k) \) is equal to

\[
\begin{align*}
\frac{dE_0 \exp\left(\frac{- (k)^2}{2\sigma_M^2}\right)}{\sqrt{2\pi}k^2\sigma_M (1 - d\Phi \left(\frac{k}{\sigma_M}\right))} &+ \frac{d^2 E_0 \phi \left(\frac{k}{\sigma_M}\right) \exp\left(\frac{- (k)^2}{2\sigma_M^2}\right)}{\sqrt{2\pi}k (1 - d\Phi \left(\frac{k}{\sigma_M}\right))^2} \\
&= \frac{dE_0 \exp\left(\frac{- (k)^2}{2\sigma_M^2}\right)}{\sqrt{2\pi}k^2\sigma_M (1 - d\Phi \left(\frac{k}{\sigma_M}\right))} \\
&\quad \left[dk \sigma_M \phi \left(\frac{k}{\sigma_M}\right) - (k^2 + \sigma_M^2) \left(1 - d\Phi \left(\frac{k}{\sigma_M}\right))\right]\right]}{\sqrt{2\pi}k^2\sigma_M (1 - d\Phi \left(\frac{k}{\sigma_M}\right))^2} \\
&= \frac{dE_0 \exp\left(\frac{- (k)^2}{2\sigma_M^2}\right)}{\sqrt{2\pi}\sigma_M (1 - d\Phi \left(\frac{k}{\sigma_M}\right)^2}} \left[\frac{\sigma_M \phi \left(\frac{k}{\sigma_M}\right) - (1 + \frac{\sigma_M^2}{k^2}) \left(1 - d\Phi \left(\frac{k}{\sigma_M}\right))\right]}{\sqrt{2\pi}\sigma_M (1 - d\Phi \left(\frac{k}{\sigma_M}\right))^2}\right].
\end{align*}
\] (33)

The derivative is negative if the term inside the square brackets in (33) is negative.

\(^{64}\)See also Figure 2.4 for the numerical simulations, showing that the value of the B bank is a declining function of the capital requirement, \( k \).
Let \( \gamma = \frac{k}{\sigma_M} \). Then the term in square brackets can be written as

\[
\left[ \frac{\sigma_M}{k} \phi\left( \frac{k}{\sigma_M} \right) - (1 + \frac{\sigma_M^2}{k^2}) \left( 1 - d\Phi\left( \frac{k}{\sigma_M} \right) \right) \right] = \frac{d\phi(\gamma)}{\gamma} - \left( 1 + \frac{1}{\gamma^2} \right) \left( 1 - d\Phi (\gamma) \right) \quad (34)
\]

\[
= \left( 1 + \frac{1}{\gamma^2} \right) \left[ d\frac{\gamma}{1 + \gamma^2} \Psi(\gamma) - (1 - d\Phi (\gamma)) \right]
\]

\[
= \left( 1 + \frac{1}{\gamma^2} \right) \left[ \frac{d\gamma}{1 + \gamma^2} \Psi(\gamma) + d\Phi (\gamma) \right] - 1
\]

For the expression (34) to be negative, \( L(\gamma) \) should be less than 1. Since \( L(\infty) = 1 \), it suffices to show \( L(\gamma) \) is monotonic increasing to conclude the proof. Hence,

\[
\frac{d}{d\gamma} L(\gamma) = \frac{2d\phi(\gamma)}{\gamma^2 + 1} > 0,
\]

concluding the proof.

### 2.7.2 Appendix B.2: Proof of Corollary 2

**Corollary 2**: Social welfare function is expected to decrease as the economy switches from the first best capital requirements to the pooling equilibrium capital requirement, \( k^* \).

Social welfare function, in any period \( t \), is defined as

\[
SW_t = s^C (\gamma_t + r_{L,t} - 1) E_0 \frac{E_0}{k^G}.
\]

Then,

\[
\frac{d}{dk} (E(SW_t)) = -s^C (\bar{\gamma} + \bar{r}_L - 1) E_0 \frac{E_0}{k^2} < 0,
\]

where \( \bar{\gamma} \) and \( \bar{r}_L \) are the expected return on good loans to the entrepreneurs and the
G banks, respectively.

Since the capital requirement for the G banks increases from $k^G$ to $k^*$, social welfare function decreases under the pooling equilibrium.

2.7.3 Appendix B.3: Proof of Proposition 3

Proposition 3: Every G bank will adopt the “IRB approach,” and will hold their first-best capital amount, $k^G$.

We want to show that the value of the G banks increases under the IRB approach. By switching to the IRB approach, G banks will enjoy a decline in their capital requirements from $k^*$ to $k^G$. Since the set-up costs are assumed to be zero for them, the only cost for the G banks in the IRB approach is the supervision cost, $C^G_S$, which is by definition very small compared to the value created by a decline in their capital requirements. Therefore, showing that the value of the G banks is a declining function of the capital requirement for $\forall k < k^*$ will conclude the proof.65

As explained in the proof of proposition 2, the decline in the capital requirement affects the value of the safe banks through two channels. First, it increases their value through increase in asset size. Remember that, holding the equity constant, the amount invested in risky assets ($A_0$) is bounded from above by $E_0/k$. Second, decline in the capital requirement increases the probability of bankruptcy ($p_G = 1 - \Phi\left(\frac{k+\mu_L-1}{\sigma_L}\right)$), and consequently decreases the value of the bank. However, the net effect on value is positive. Recall that,

$$V(\beta = 1, k) = \frac{dE_0}{k} \left[ \frac{\sigma_F}{\sqrt{2\pi}} \exp \left[ \frac{-(1-(k+\mu_L))^2}{2\sigma_L^2} \right] + \Phi\left(\frac{(k+\mu_L)-1}{\sigma_L}\right) \left(\bar{r}_L - 1\right) \right] \left[ 1 - d\Phi\left(\frac{(k+\mu_L)-1}{\sigma_L}\right) \right]^{-\lambda}.$$

Note that we set $p = 0$ in this analysis just for simplicity, the result is unaffected with

65See also Figure 2.4 for my numerical simulations, showing that the value of the G bank is a declining function of the capital requirement, $k$. 

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\( p > 0 \). We would like to prove that

\[
\frac{d}{dk}(V(\beta = 1, k)) < 0, \forall k < k^*.
\]

Let \( \alpha = (k+\bar{r}_L)^{-1} \). Then

\[
V(\beta = 1, k) = \frac{E_0}{k} \left\{ \frac{d\sigma_L(\alpha)}{[1-d\Phi(\alpha)]} + (\bar{r}_L - 1) \left[ \frac{1}{[1-d\Phi(\alpha)]} - 1 \right] \right\}_{A(\alpha)}
\]

If we differentiate the value function with respect to the capital requirement, we get

\[
\frac{d}{dk}(V(\beta = 1, k)) = -\frac{E_0}{k^2} A(\alpha) + \frac{E_0}{k} A'(\alpha)
\]

\[
= \frac{E_0}{k} [A'(\alpha) - V(\beta = 1, k)],
\]

where

\[
\frac{dA(\alpha)}{dk} = \frac{dA(\alpha)}{d\alpha} \frac{d\alpha}{dk}
\]

\[
= \frac{1}{\sigma_L} \frac{d\phi(\alpha)}{[\bar{r}_L - 1] - \sigma_L \alpha + d\sigma_L \alpha \Phi(\alpha) + d\sigma_L \phi(\alpha)}
\]

\[
= \frac{d\phi(\alpha)}{\sigma_L [1-d\Phi(\alpha)]^2 \left( -k + d\sigma_L \left( \alpha \Phi(\alpha) + \phi(\alpha) \right) \right)} \]

and (36) follows by simply plugging \( \alpha = (k+\bar{r}_L)^{-1} \).

The derivative \( \frac{d}{dk}(V(\beta = 1, k)) < 0 \) if and only if

\[
A'(\alpha) - V(\beta = 1, k) < 0.
\]

We would like to find the region of parameter \( k \) for which the above holds. Instead, we focus on another region, which is in fact a subregion of the original one. Let it be
composed of \( k \) such that \( A'(\alpha) < 0 \). Note that this condition is not a necessary but a sufficient condition for \( \frac{d}{dk}(V(\beta = 1, k)) < 0 \). From (36), an equivalent condition is

\[
d\sigma_L (\alpha\Phi(\alpha) + \phi(\alpha)) < k
\]

(37)

Recall that \( \alpha = [(k + \tilde{r}_L) - 1]/\sigma_L \) and thus both sides of (37) is a function of \( k \). This non-linear inequality would determine the sub-region, i.e., the value \( k_{\text{min}} \) such that all \( k > k_{\text{min}} \) the derivative is negative. Instead of trying to evaluate \( k_{\text{min}} \), we check whether \( k^G \) is a part of the region, namely, we check whether \( k^G > k_{\text{min}} \). Note that based on equation (30), the value of \( k^G \) is determined by the non-linear equation

\[
\alpha\Phi(\alpha) = \phi(\alpha).
\]

(38)

Thus, to check whether (37) holds for \( k = k^G \), it suffices to check

\[
2d\sigma_L\phi(\alpha) < k^G,
\]

(39)

where \( \alpha = \frac{(k^G + \tilde{r}_L) - 1}{\sigma_L} \). We know that \( \phi(\alpha) \approx 0 \) for the G banks. Thus, for a reasonable value of \( k^G \), \( \frac{d}{dk}(V(\beta = 1), k) < 0 \) for all \( k > k^G \), including the pooling equilibrium capital requirement, \( k^* > k^G \).

Therefore, it is always better for the G banks to identify themselves by using the IRB approach, so that they can hold less capital, which is equal to their first-best ratio \( (k^G) \), and consequently can increase their size.

2.7.4 Appendix B.4: Proof of Proposition 5

Proposition 5: Given the supervision and set-up costs for the banks and the probability of being caught as a B bank pretending to a G bank under the IRB approach, there exists a \( k^*_{\text{new}} \) such that the following separating
equilibrium exists.

1. G banks switch to the IRB approach, and their capital requirement is $k^G$.

2. B banks stay in the old system of standardized approach if their capital requirement will be $k^*_\text{new} - \varepsilon$, where $k^G < k^*_\text{new} < k^B$ and the following equation is satisfied.

$$V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_F = V(\beta = 0, k^*_\text{new}).$$

We want to show that we can find a $k^*_\text{new}$ such that the equilibrium, in which G banks choose to adopt the IRB approach, and B banks have an incentive to stay in the old system, is a separating Bayesian Nash Equilibrium. That means no bank type has an incentive to deviate, and bank actions on the equilibrium path are consistent with the beliefs. Equilibrium beliefs ($\mu$) are,

$$\mu(\text{type}=G|\text{IRB Approach}) = 1$$

and

$$\mu(\text{type}=B|\text{Standardized Approach}) = 1.$$  

For the first part of the proposition, see the proof for Proposition 3, where we showed that G banks always adopt the IRB approach in order to identify themselves to the regulator for the parameters of our interest. In other words, G banks have no incentive to stay in the standardized approach.

For the second part, we need to show that there exists a $k^*_\text{new} - \varepsilon$ such that $k^*_\text{new}$ satisfies the following condition.

$$V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_F = V(\beta = 0, k^*_\text{new})$$  \hspace{1cm} (40)
where $k^G < k^{\new}_* < k^B$.

Analytically, the existence of $k_{\new}^*$ that satisfies (40) such that $k^G < k_{\new}^* < k^B$ is trivial. Since the left hand side of the above equality is declining in $C^B_f$ and $C^B_S$, and under the standardized approach $C^B_f = C^B_S = 0$

$$V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_f < V(\beta = 0, k^G). \quad (41)$$

Also, we assumed an upper bound on set-up costs ($C^B_f$) using

$$V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_f > V(\beta = 0, k^B) \quad (42)$$

Since, as we showed in Proposition 1, the value of the B bank is a declining function of $k$, equations (41) and (42) imply that there exists a $k_{\new}^*$, where $k^G < k_{\new}^* < k^B$, that

$$V^{IRB}(\beta = 0, k^G, C^B_S) - C^B_f = V(\beta = 0, k_{\new}^*).$$

Therefore, there exists a $k_{\new}^* - \epsilon$ such that $k_{\new}^*$ satisfies the equation (40), concluding the proof.

2.7.5 Appendix B.5: Proof of Corollary 6

Corollary 6: Compared to the pooling equilibrium under the standardized approach (as described in Proposition 1), the separating equilibrium, in which all the G banks adopt the IRB approach and all the B banks stay in the standardized approach (as described in Proposition 3), increases the social welfare function.

The proof is very similar to the proof of the Corollary 2. If the G banks adopt the IRB approach, their capital requirement decrease to the first-best value, $k^G$. 125
Remember that the social welfare function, in any period $t$, is defined as

$$SW_t = s^G(\gamma_t + \tau_{L_t} - 1)\frac{E_0}{k^G}$$

and

$$\frac{d}{dk} (E(SW_t)) = -s^G(\bar{\gamma} + \bar{\tau}_L - 1)\frac{E_0}{k^2} < 0,$$

where $\bar{\gamma}$ and $\bar{\tau}_L$ are the expected return on good loans to the entrepreneurs and the "G" banks, respectively.

Therefore, holding equity constant the size of the G banks and consequently social welfare function increases under the separating equilibrium. This concludes the proof of the corollary.

### 2.8 Appendix C

This appendix lists the parameter values used in the numerical simulations that produce the figures 2.1 - 2.4. Numerical simulations are run because $\beta$ does not have a closed form solution, therefore $V(\beta)$ can be only numerically solved. Remember that

$$V(\beta) = (1 - df(\beta))^{-1}d [g(\beta) + f(\beta)(\mu_r - 1 - p(1 - k))A_0] \quad (43)$$

where

$$f(\beta) = \Phi \left[ \frac{(k + \mu_r) - 1}{\sigma_r} \right] \quad (44)$$

and

$$g(\beta) = A_0 \frac{\sigma_r}{\sqrt{2\pi}} \exp \left[ \frac{-(1 - (k + \mu_r))^2}{2\sigma_r^2} \right]. \quad (45)$$

The expected return and variance of the good loans are chosen based on the descriptive statistics of the loan spreads, covered by the Survey of Terms of Business.
Lending over four quarters of 2003. The survey provides quarterly loan-level data on commercial and industrial loan extensions of about 300 US banks. Risk-free gross return is normalized to 1 in the paper. Note that, in 2003, the 6-month and 1-year Treasury rates were, on average, 1.1% and 1.29%, respectively. The capital requirement is assumed to be binding for the bank, i.e.

\[ E_0 = kA_0. \]

Below are the parameter values used in the numerical simulations resulted in the figures 2.1 - 2.4.\(^{66}\)

- Initial Value of the Equity: \( E_0 = 0.08 \)
- Capital Requirement Ratio: \( k = 0.08 \)
- Value of the Risky Assets: \( A_0 = \frac{E_0}{k} = 1 \)
- Expected Gross Return on Good Loans: \( \tilde{r}_L = \{1.0175, 1.0375\} \)
- Expected Gross Return on Risky Loans: \( \tilde{r}_M = 1 \)
- Variance of the Good Loans: \( \sigma^2_L = 0.01 \)
- Variance of the Risky Loans: \( \sigma^2_M = 0.1 \)
- Probability that Next Period is not the Last Period of the Bank: \( d = 0.99 \)
- Deposit Insurance Premium\(^{67}\): \( p = \{0, 0.0015\} \)

\(^{66}\)The shape of the value function is robust to using other parameter values, as well.  
\(^{67}\)The fixed-rate premium charged by the FDIC is about 1.25% (See Pennacchi (2005)). Since the risk-free rate is normalized to zero in this paper, we set the insurance premiums either to zero or close to zero in our numerical simulations.
FIGURE 2.1: This figure shows how the value of the bank, $V(\beta)$, changes as the ratio of the investment in safe asset ($\beta$) changes from 0 to 1 and the variance of the return on risky asset ($\sigma^2_M$) changes from 0.01 to 0.01. The values of the other parameters used are as follows: $E_0 = 0.08$, $k = 0.08$, $A_0 = 1$, $\bar{r}_L = 1.0175$, $\bar{r}_M = 1.0$, $\sigma^2_L = 0.01$, $d = 0.99$, and $p = 0.0015$. Value of the bank, $V(\beta)$, is as defined in equation (43). Note that, when the variance of the risky loan is equal to the variance of the good loan, the bank optimally sets $\beta^* = 1$ because the expected return on the good loan is higher. However, holding other parameters constant, as the variance of the risky loan increase, $\beta^*$ changes from 1 to 0. See the points, corresponding to $V(\beta^*)$ and $\beta^*$, identified by diamonds in the figure.
FIGURE 2.2: This figure shows how the value of the bank, $V(\beta)$, changes as the ratio of the investment in the safe loan ($\beta$) changes from 0 to 1 for two different values of the expected return on good loans: $\bar{r}_L = 1.0175$ and $\bar{r}_L = 1.0375$. The values of the other parameters used are as follows: $E_0 = 0.08$, $k = 0.08$, $A_0 = 1$, $\bar{r}_M = 1$, $\sigma^2_L = 0.01$, $\sigma^2_M = 0.1$, $d = 0.99$, and $p = 0.0015$. The value of the bank, $V(\beta)$, is as defined in equation (43). Note that, holding other parameters constant, as the expected return on the safe loan increase by 2%, the bank’s optimal investment switches from $\beta^* = 0$ to $\beta^* = 1$. 

$\text{Value of the Bank as a Function of Beta}$

- expected gross return on safe asset=1.0375
- expected gross return on safe asset=1.0175
FIGURE 2.3: This figure shows the first-best values of the capital requirements for the "G" and "B" banks, $k^G$ and $k^B$, that satisfy the equations (20) and (21), respectively. On the y-axis is the "expected premiums minus loss" to the deposit insurance fund, $E(\text{InsurancePremium}_t^i - \text{Loss}_t^i)$, and on the x-axis is the capital requirement ratio, $k$. First-best value of the capital requirement for the G and the B bank, $k^G$ and $k^B$, make the expected premiums minus loss on the y-axis equal to zero. The values of the other parameters used are as follows: $E_0 = 0.08$, $k = 0.08$, $A_0 = 1$, $\bar{r}_L = 1.0375$, $\bar{r}_M = 1.0$, $\sigma^2_L = 0.01$, $\sigma^2_L = 0.1$ $d = 0.99$, and $p = 0.0015$. Note that, $k^G << k^B$. 

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FIGURE 2.4: This figure shows how the value of the bank, \( V(\beta) \), changes as the capital requirement, \( k^* \), changes from 0.01 to 0.10 for the two types of banks: "G" banks (with \( \beta^* = 1 \) and \( \bar{\tau}_L = 1.0375 \)) and "B" banks (with \( \beta^* = 0 \) and \( \bar{\tau}_M = 1 \)). The values of the other parameters used are as follows: \( E_0 = 0.08 \), \( A_0 = kE_0 \), \( \sigma^2_L = 0.01 \), \( \sigma^2_M = 0.1 \), \( d = 0.99 \), and \( p = 0.0015 \). The value of the bank, \( V(\beta) \), is as defined in equation (43). Note that \( V(\beta) \) is a declining function of \( k \) for both type of banks.