YING XU

# Empirical Essays on the Stock Returns, Risk Management, and Liquidity Creation of Banks

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**Empirical Essays on the Stock Returns, Risk Management, and Liquidity Creation of Banks**

Empirische Studies betreffende Aandelenrendementen,
Risico Management, en Liquiditeitscreatie van Banken

Thesis

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by

Ying Xu
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## Foreword

It is to me inconceivable that I can manage to complete this dissertation and my doctoral study without the contributions from many people. Foremost, I would like to thank Ronald Mahieu who introduced me to the academic world by accepting me as his doctoral student. He has always been my reliable source of support and intellectual inspiration ever since the days of my study in the M.Phil. program. I am excited by our cooperation that will continue in the years to come

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It is also unimaginable to me to have been able to go through the past few years without the encouragement from and the laughter with the many colleagues and friends at Erasmus University and ABN AMRO. Being with them makes me feel at home and keeps me motivated in what otherwise would have been unbearably lonely and tedious times.

Last but not least, I would like to thank my parents. They always support and believe in me even when I don't have faith in myself.

Like an earlier PhD graduate from Erasmus University adequately put it, the most trivial function of a doctoral dissertation is to obtain the degree. Even though the contents of this thesis are the results of backbreaking works, it is still merely a starting point for the ever more challenging journeys in my future professional and personal lives where I will put what I learned during my doctoral study into practice. In this sense, the conclusion of a PhD study is not in itself a victory. It is merely a small step further away from ignorance and the start of what hopefully will be a more enlightened lifelong learning.

Ying Xu
Rotterdam, The Netherlands
November 2009

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# Chapter 1

# Introduction

## 1.1 Background

At the time of this writing, the global economy is in the middle or hopefully at the end of the worst financial crisis since the Great Depression. In many aspects, the financial institutions, particularly the commercial banks, are at the center of this financial epidemic. Loosely speaking, the cause of the crisis is typically attributed to three, possibly intertwined, problems in many banks: high leverage fueled by cheap credits, involvement in complex derivative products, and low capital cushion against unexpected losses. Inadvertently, or perhaps inevitably when writing about banks, the chapters in this thesis are connected to the current financial crisis and its attributes. In this introduction, I briefly discuss the contents of each chapter of this dissertation and put them in the context of the existing banking literature and the current economic situation.

To start with, readers may agree that commercial banks are indispensable in everyday life. It is inconceivable that anyone in the modern society can live without the interaction with banks for a prolonged period of time. From the purchase of groceries using various types of bank cards, the withdrawal of cash from the ATMs, to the purchase of cars or housing facilities using mortgages or other types of bank loans, the daily activities of individuals are intertwined with banks. Companies of various industries, structures, and sizes are used to the frequent and routine interactions with banks in many different aspects of business operations in the whole cycle of their existence, from establishment to the disappearance due to merger or acquisition or bankruptcy.

The existence of banks seems so mundane that I wonder how many people really think about the risks they are taking on when depositing their savings into certain banks or think about the risks the banks are taking on when granting a mortgage loan. Of course, as happened in many countries during the current and past financial crises, all this comfort and familiarity can instantly become fear and panic when facing an (expected) outburst of financial crisis or the prospect of bank failure. In such a situation, individual depositors may withdraw their deposits as quickly as they can, or refuse to pay their loan obligations. Companies would also become reluctant to continue their otherwise routine interactions with those troubled banks. Therefore, it all seems that banks are crucial to the well-being of our societies and the individuals therein. But at the same time the economic health of our society seems all too vulnerable to the problems in the commercial banks.

It then may sound shocking that banks or financial institutions in general are of little relevance in financial theories. Indeed, Franklin Allen in his presidential address to the American Finance Association in 2000 suggest that "…people might be surprised to learning that institutions play little role in financial theory", and that "financial institutions…would be ignored" (Allen 2001). As it turns out, as Allen (2001) concludes, financial institutions matter a lot in reality because of the agency problems between the ultimate owners of financial assets and the managers of the institutions that maintain these assets.

In addition, the agency problems associated with banks are somehow more complicated because not only are the direct investors in banking products, e.g., depositors or shareholders, affected, but the general public and the overall economy may be in jeopardy if the banks collectively encounter troubles. The problems are further exacerbated by the fact that banks are opaque enterprises, which means it is very difficult for outsiders to accurately assess the true level of risks of a bank. As a consequence, the public tends to extrapolate the surfaced problem of one bank to all other banks assuming that the proven problem of a typical bank is very likely to exist in other similarly opaque institutions as well. Therefore, as during the Great Depression and sub-prime crisis, depositors tend to simultaneously withdraw their bank deposits after the observation of financial distress of one bank even though there is no direct sign of insolvency in other banks.

This thesis addresses three issues closely related to the special issues of banks. Each of these issues is particularly relevant to a certain audience. I also discuss the relevance of the chapters in this thesis to the current financial crisis. The next section summarizes Chapter 2, which analyzes the stock returns of banks listed in the major U.S. stock markets and hence it is an interesting read for bank stock investors or analyst covering the financial sectors. Section 1.3 briefly covers Chapter 3, which discusses the use of interest rate and credit derivatives for hedging purposes by all U.S. banks that participate in the derivative market. For regulators and other stakeholders of banks' lending activities and their use of derivatives for risk mitigation, this chapter provides some evidence on the impact of derivatives that may deserve more attention. Section 1.4 summarizes Chapter 4 that investigates the real effect of bank capital regulation on bank liquidity creation. For regulators that try to improve banking stability by requiring banks to hold more capital, this chapter demonstrates the downside of such requirements. This chapter also examines the effect of competition on bank liquidity creation.

### 1.2 The Pricing of Banks Stocks

Chapter 2 of this thesis is devoted to the investigation of bank stock returns. The focus of this chapter is motivated by the shortfall in the existing asset pricing literature regarding the attention paid to financial sectors in general and banks in particular. For example, in a widely cited paper on the cross-section of stock returns by Fama and French (1992), financial stocks are deliberately excluded because the authors intend to investigate the pricing implication of leverage and stock returns and do not want to mix industrial sectors with financial sectors where the leverage ratio is typically much higher. Most subsequent efforts in asset pricing also exclude financial stocks in order to be comparable with the earlier results.

Even in the rare cases where financial stocks are investigated, the starting assumption is usually that the pricing factors found in the non-financial sectors also apply to the financial stocks. Examples of these contributions include Barber and Lyon (1997) and Cooper et al (2003). These papers typically build on the pricing factors suggested by Fama and French (1992) in the context of non-financial sectors and apply these factors directly to banks or other financial institutions. Intentionally or inadvertently, the applicability of these factors in a new environment has never been questioned.

Considering the special nature of financial institutions, such as high leverage and being heavily regulated, it is conceivable that the traditional pricing factor may not have the same relationship with bank stocks as in other industries. The rich body of theories of financial intermediation and banking economics may also provide the foundation for hypothesizing some relationship between bank-specific characteristics and bank stocks that could be unorthodox in the existing asset pricing literature. Yet such possibilities have not been rigorously examined in the existing literature.

Chapter 2 of this thesis takes the first step in filling in the gap in the existing asset pricing literature regarding the banking industry by trying to address the question if there are sector-specific variables that may help explain bank stock returns. As will be shown in this chapter, the theories of financial intermediation and banking economics seem to suggest that some variables, shown to be negligible in non-financial stocks, are likely to be relevant to the performance of bank stocks. Therefore, it seems necessary to explore the empirical implications of these bank specific variables and see if they have a stronger relationship with bank stock returns than do the existing prominent pricing factors.

Based on an extensive review of the banking literature, I examine the effect of bank leverage and bank size on bank stock excess returns. While leverage has been shown to be inconsequential in the context of nonfinancial stocks, my results suggest a consistent and statistically strong and positive relationship between leverage and future bank stock excess returns. Banks that are highly leveraged, or have lower equity, have higher returns. This relationship is strong in both univariate models and in multivariate models that control for other bank characteristics and risk profile. This suggests that the investors of bank equity may have inadvertently exacerbated the buildup of high leverage in banks prior to the 2008/2009 financial crisis by giving the signal through bank stock returns that high leverage is more desirable. Bank size measured by total assets, on the other hand, has a significantly negative impact on bank stock returns. This could be seen as evidence for the diversification discount observed by Laeven and Levine (2007) where large and diversified financial conglomerates are worth less as a whole than the sum of their components if torn apart.

In addition, the existing asset pricing literature for banks or financial firms typically neglects beta as a pricing factor because it has been shown in the non-financial firms that beta seems irrelevant. My results in the banking sector demonstrate a strong and convex non-linear relationship between bank stocks returns and beta. Bank stock excess returns initially decreases with the increase of beta, but picks up again once beta becomes sufficiently small. Therefore, unlike in the non-financial world where beta is shown to be negligible, the performance of bank stocks is likely to bear a close relationship with beta.

All in all, the central message of this chapter is that some established asset pricing factors in the non-financial industries do not seem to directly apply to the banking industry. The meaningful decomposition or prediction of expected bank stock returns may benefit from the theories of financial intermediation and banking economics and from the inclusion of some bank-specific pricing factors.

In the context of the current financial crisis, the findings in this chapter that leverage may play an important role the pricing of bank stocks seems justifiable. One of the causes for the troubles at many banks during the subprime crisis is the dangerously low level of capital many banks had prior to the crisis. As a consequence, many banks became insolvent or, in the case of some major U.S. banks and many European banks, had to rely on government capital injection to stay away from bankruptcy. The high excess stock returns associated with high leverage during the twenty years prior to the subprime crisis shown in Chapter 2 suggest that investors of bank equities may have inadvertently signaled that high leverage is a virtue which makes banks more valuable. During the subprime crisis, such a virtue instantly turned sour as many investors dumped stocks of high leveraged banks. Should future research investigate the relationship between bank stock returns and leverage during the crisis period, my suspicion is that a strong but negative relationship is conceivable. What the nature of this relationship will be after the dust of the current crisis has settled remains to be seen. Nonetheless, one important message from chapter 2 is that bank leverage is crucial to the welfare of bank equity investors.

### 1.3 Hedging with derivatives

The explosive growth of the derivative market and the promulgation of the use of derivative products by banks have been the center of debate for both policy-makers and practitioners for many years. The debate has intensified especially after the bankruptcy of Barings Bank, the debacle of Long Term Capital Management in 1998 and, more recently, the subprime crisis. The concern regarding derivatives has mainly been with their complexity and the fact that derivative users are very much intertwined, which increased the likelihood of systemic risks. Systemic risks mean that the failure of one counterparty of derivatives leads to a cascade of bank failures because the derivative contracts that connect these banks cannot be paid out by the failed bank.

A more fundamental question that has received less attention is why banks use derivatives in the first place and what the relationship is between the use of derivatives and the day-to-day operations of banks. This is a more fundamental question because if there is a close relationship between derivatives and basic bank functions such as loan initiation, then the impact of derivatives on the economy will not only be visible during crises but in normal times as well.

Chapter 3 of this thesis examines the use of interest rate and credit derivatives for hedging by U.S. bank holding companies (BHCs). One emphasis of this chapter is on the contribution of banks' loan making activities, both on- and off- balance sheet, to the likelihood of use of derivatives for hedging purposes. It is shown that while the on-balance sheet loans have little to do with banks engagement in interest rate and credit derivative, the off-balance sheet loan commitment appears to significantly increase the likelihood of a bank to become a user of interest rate derivative for hedging. In addition, there is a significantly negative relationship between interest rates and term spread and the likelihood of hedging with interest rate derivatives. This phenomenon should be explained by the effect of interest rate movements on maturity gap. As interest rate rises, the market value of any maturity gap, positive or negative, becomes smaller which reduces interest rate risk exposure and the need for hedging. This explanation is supported by the evidence that the relationship between interest rate and the likelihood of hedging with interest rate derivative is significantly negative for banks with both positive and negative maturity gap.

The use of credit derivatives is mainly associated with banks' engagement in the trading of credit derivatives. Large banks are more likely to be users of credit derivatives. More profitable banks, as measured by interest margin, are less likely to be a derivative user for hedging. When it comes to the adjustments of credit derivatives, banks that have increased use of securitization are also more likely to use more credit derivatives. In other words, different off-balance sheet hedging instruments are likely to coexist.

In the context of the current financial crisis, the findings of this chapter add to the evidence on the impact of derivatives on the real economy. Warren Buffet once labeled derivatives "financial weapons of mass destruction". In essence, the danger of derivatives lies in their potential to cause a chain reaction of default among all involved parties. The findings in this paper imply that the negative spillover from the insolvency of the derivative market can easily cause the financing to other industries to dry up, since banks' ability to roll over their existing loans to companies greatly depends on derivatives. In hindsight at the time of this writing, such findings may sound obvious or even outdated. However, when the first version of chapter 3 was completed in late 2006, the idea that derivatives, the feat of financial engineering that is creating massive profit and liquidity at the time for banks and borrowers, could cause the financial market to dry up sounded suspicious at the best.

### 1.4 Bank liquidity creation

For a number of reasons, the European banking industry is an interesting area for empirical banking research. First, the European financial markets are considered bank-based systems where banks are the major liquidity providers for business. Whether or not such a bank-oriented financial market translates into stronger capability of European banks in liquidity creation is an interesting empirical question. Second, the European banking sector has been remarkably transformed in the past couple of decades by regulatory developments. For example, the Second Banking Directive adopted by European Union (EU) in 1995 allowed banks to freely operate in other EU countries by setting up branches or directly offering a full range of banking services. These regulations have implications on both the level of competition of the banking sector as a whole and the competitive position of individual banks in particular. It is of great policy relevance to investigate how the liquidity creation activities of banks are affected by the policy developments and the resulting competition issues. Next, the attitudes towards banking stability held by European and the U.S. governments are quite different. While it is a firm belief in Europe that banks in Europe will not be allowed to fail so that depositors would suffer losses, across the Atlantic, bank failures in the U.S. take place more often. Such a contrast in regulatory ideologies raises the question regarding the role of banks' own equity capital as a cushion against bank failures or banking risks in general. Given the debate currently undergoing that aims at requiring banks to hold more capital, the empirical substantiation of this issue has profound policy implications.

In Chapter 4, we investigate the above issues using a unique and comprehensive dataset that covers the majority of banks in EU for the period between 1998 and 2004. The most important questions we address include how much liquidity European banks create, what is the relationship between bank equity capital and liquidity creation in Europe, and how bank liquidity creation relates to the competitive environment of the banking industry.

The results can be summarized as follows. First, our liquidity creation measurement corroborates with the literature on financial system comparison that suggests European economies rely more on bank financing. The amount of liquidity created by European banks as a percentage of GDP is much higher than banks in the U.S.

Next, we investigate the relationship between bank equity and liquidity creation and thereby shed light on the potential impact of the recent shift in regulatory focus on strengthening bank capital base. Our results show that increased bank equity capital would substantially reduce bank liquidity creation by all banks across Europe. Such a conclusion could be understood in the context of consistent government interventions and protections during banking crisis by European governments. Such a regulatory environment results in an ideology that banks will never be allowed to fail, which in turn reduces the (perceived) necessity to hold equity capital.

Additionally, we show that the market share of individual banks has a significantly positive relationship with liquidity creation. We take this as evidence on the stronger ability possessed by banks with larger market share to retain customers and inter-temporally smooth interest charges so that risky and illiquid loans can find financing (Petersen and Rajan 1995). More investments in these loans in turn increase bank liquidity creation.

In view of the current financial crisis, the most relevant connection with Chapter 4 concerns the relationship between equity capital and liquidity creation. As the subprime crisis unfolds, central banks around the globe and international organizations such as Bank for International Settlements have been arguing for the importance of bank equity capital and formulating new regulatory frameworks that aim at strengthening the capital structure of banks. Even though Chapter 4 does not negate the merit in the new regulatory emphasis, it points to a potentially undesirable side effect at least in Europe. Specifically, we show that in Europe there is a significantly negative association between equity capital and liquidity creation, which might be caused by the perception that European governments are more protective of their banks and would not allow banks to fail and depositors to suffer losses. Such a belief has also been substantiated by the many rescues of failing banks led by European governments in the past. Requiring banks to hold more capital of their own may not be credible and effective in such an environment because banks expect the government to bail them out during crisis. Forcing banks to hold more capital may reduce their liquidity creation and slow down economic growth and recovery.

Ironically, during the aftermath of the subprime crisis, almost all major European governments yet again provided support of various kinds to prevent their banks from failing, which may further strengthen banks' future reliance on the government and reduce their incentive to hold capital. Forcing banks to hold more capital may become even more counterproductive during the recovery from the current crisis. It will be interesting to observe the future development of the European banking industry and the regulatory response.

# Chapter 2

# The Cross-Section of Expected Bank Stock Returns

## 2.1 Introduction

The literature on the cross-sectional determination of bank stock returns is relatively limited. Banks or financial sectors in general are excluded by most studies of stock returns because the values of some pricing factors for these firms are very different from other firms traded in the stock market. For example, Fama and French (1992) exclude financial firms because "…the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms…". Yet the financial sector, in particular banking firms, forms a vital part of the economy and their shares also occupy a large percentage of the total market capitalization of most stock markets in the developed economies. The total omission of these firms cannot be justified.

The highly limited amount of literature that focuses on the stock returns of banks has to some extent contributed to the remedy of such an omission. Barber and Lyon (1997) use financial firms' stock returns as a hold-out sample to validate the findings by Fama and French (1992) that size and book-to-market ratios have significant relation with stock returns. However, this paper did not attempt to tap into the vast literature on financial intermediation and banking economics in order to discover independently the relevant or additional pricing factors for financial firms. Rather, it is an exercise that takes for granted the existing pricing factors found in nonfinancial sectors and applies them in the financial sectors. Therefore, it is likely that some important pricing factors relevant for bank stocks have been overlooked.

Cooper et al (2003) take further steps by investigating a variety of bank-specific variables in their study of bank stock returns. Their primary focus however is not on the examination or determination of pricing factors that underlie bank stock returns. Rather, the paper is targeted at the source of variation of bank stock returns. As a result, the authors apply the changes of several potential pricing factors to their study of the variation of stock returns and thereby try to determine if the cause of banks stock return predictability is due to over- or under- reaction by investors to the variation of the pricing factors.

Therefore there seems to be a gap in the study of bank stock returns. On the one hand, we have evidence showing that the pricing factors found to be useful in the study of nonfinancial stock returns also seem to apply to bank stock returns (Barber and Lyon 1997). On the other hand, Cooper et al (2003) directly go to the study of investors' reaction to the *variations* of certain pricing factors. What is missing in between is the exploration and documentation of the bank-specific variables that could contribute to the explanations of expected bank stock returns.

This paper takes the first step to fill in this gap. We start by reviewing the literature on financial intermediation and banking economics to summarize the special features of financial institutions. We pay special attention to the literature that relates to bank equity capital and its association with other bank balance sheet items and thereby hypothesize the existence and direction of pricing relationships. Next we empirically investigate if indeed the hypothesized pricing relationship can be verified with real data. To this end, we collect comprehensive bank balance sheet data for all publicly traded banks in the U.S., which are also within the scope of the Bank Holding Company database maintained by the Federal Reserve Bank of Chicago. Our empirical approach follows closely the classical style of Fama and French (1992). Specifically, we form portfolios based on the intersections of the ranking of hypothesized pricing factors in the universe of U.S. banks and calculate the average stock returns of the portfolios. This approach allows us to see the effect of a particular pricing factor on stock prices individually or conditional on other potentially compounding factors. The next step is to more rigorously determine the sensitivity of stock prices to the pricing factors by means of regression analysis. The findings in the ranking-based portfolio approach are herein corroborated by regressing the stock returns on the hypothesized pricing factors in a univariate or multivariate context.

At the minimum, our results point out a few abnormalities compared with literature in non-financial stocks. We found that a simple measurement of bank leverage calculated from bank total assets and total equity capital is monotonically related to future bank stock excess returns. In the context of regression analysis, leverage is a strong explanatory variable that consistently has positive signs in both univariate and multivariate settings and remains robust across different model specifications. We also examined other conceivable measurements for leverage, such as one that includes illiquid liabilities, and risk adjusted leverage ratios that weigh the components of equity and assets according to the Basel II framework. These alternative leverage ratios do have consistent signs with the simple total assets-total equity based leverage ratio, but the later one has the highest level of statistical significance. The implication of this finding is that investors may have rewarded banks with high levels of leverage and thereby signal to the banks to hold less equity capital[1].

Next, unlike the existing literature that assumes the irrelevance of beta based on the findings in the non-financial sectors (see, e.g., Barber and Lyon 1997, Cooper et al 2003, and Viale et al 2009), our results show that beta seems to be an important pricing factor for bank stocks. Beta by itself seems to be a strong and negative predictor of future bank stock returns. Furthermore, we find that the relationship between beta and bank stock returns appear to be nonlinear and convex. Returns initially fall with the rise of beta. But after beta has reached a certain threshold, stock returns begin to increase together with beta. Regression analyses validate this convex relationship. Beta itself always has a strong and negative sign in both univariate and multivariate settings and across different model specifications. The square of beta however consistently has positive and significant sign, signaling a nonlinear and convex function.

Finally, we investigate the pricing effect of bank size. Unlike the existing literature for both non-financial and financial stocks that mostly measure size by market capitalization, we also take into account the size of a banks total balance sheet. We find a consistently negative relationship between bank total assets and future stock returns. The link between market capitalization and stock returns however is negligible. We interpret such a finding as a supporting evidence for the diversification discount theory maintained by Laeven and Levine (2007) stating that large and more diversified banks are worth less than the sum of their constituent parts if separated. This relationship between size and bank stock returns seems to differ from what Fama and French (1992) document in the non-financial sectors, which absorbs the relationship between beta and stock returns. In other words, in the sample of Fama and French (1992), size substitutes beta. In our study however, the relationship between size and bank stock returns is persistently strong irrespective of beta.

By and large, one central message of this paper is that bank stocks very likely have their special characteristics and underlying determinants that fundamentally differ from non-financial stocks. Therefore, the treatment of bank stocks in the same way as non-financials may be questionable. More specifically, the pricing factors relevant to nonfinancial stocks are not necessarily crucial to bank stocks. The reverse is also true, as indicated by the aforementioned importance of leverage and bank stock returns, that important pricing factors for banks may not be relevant to non-financials. Therefore, the main contribution of this paper

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[1] One example of such tales is the takeover of ABN AMRO by a consortium led by Royal Bank of Scotland. In the annual shareholder assembly in 2007 prior to the takeover, 95% of RBS shareholders gave their favorite vote to the highly leveraged bid, which eventually brought the bank into government ownership during the financial crisis of 2008/2009.

is our systematic discovery and documentation of asset pricing factors specific to banks.

The rest of the paper is organized as follows. In the next section, we review the existing literature on financial intermediation and banking economics that may be relevant for the study of bank stocks. In the meantime we also hypothesize the direction of the impact of the potential pricing factors extracted from the theories. In Section 2.3, we describe the data sources, data collection and cleansing criteria, and procedures for portfolio formation. Section 2.4 shows the results of the summary statistics of the portfolios and the outcome of some preliminary analysis of the relationship between bank stock returns and the pricing factors. The regression results are shown in Section 2.5. The results from robustness tests are shown in Section 2.6. The last section concludes the paper.

### 2.2 Literature review

In this section, we extract from the existing banking literature the fundamental variables that may have implications on the performance and riskiness of banks and hence can be conceived as potential pricing factors in our later study of the cross-section of bank stock returns. In contrast to Fama and French (1992, 1993) who focus on the pricing factors primarily rooted from the non-financial sectors, our search for the fundamental variables pay close attention to the financial sector in general and the banking industry in particular. Also in contrast to Cooper et al (2003) who devoted considerable attention to such “exotic” variables as derivatives, loan commitments that are mostly present and relevant to a very limited number of banks (Minton et al 2008 and Chapter 3 of this thesis), we stick to the most basic balance sheet variables that are easy to find and construct and also relevant to all banks. After all, it is our goal to shed light on the relationship between bank fundamentals and the cross-section of bank stock returns and thereby fill in the gap in the current literature in this regard.

The first fundamental variable we extract is the leverage of banks. In the context of the banking industry, leverage, i.e., the extent to which the bank is financed by borrowed funds instead of equity capital, has considerably different implications than in other industries. Diamond (1984) suggests that the optimal capital structure for banks is to be financed with primarily deposits and very little equity capital. This is because of the incentive problems between depositors and banks as the intermediary between the borrowers and the depositors. This incentive problem relates to the profit sharing between banks, who closely monitor the behavior of the borrowers regarding their observations of the loan contract and ensure their repayment, and the depositors, who ultimately provide the funds the borrowers receive through the banks. Deposit as a form of debt is the optimal financing source because it ensures banks to pass on the profits from the borrowers to the depositors. If the bank refuses to comply, the depositors would withdraw their funds from the bank and force the bank to liquidate otherwise profitable loans prematurely and end up with zero or negative returns. Diamond and Rajan (2000) further show that a fragile bank capital structure that primarily consists of deposit is beneficial for the liquidity creation function of banks as financial intermediaries. The intuition is that deposits are subject to runs, which can be triggered if banks hold off their monitoring or collection effort with regard to the loans made to borrowers or if banks withhold profits earned from the loans. Therefore, a fragile bank balance sheet alleviates the incentive related agency problems between depositors and the bank, and in turn helps maintain the viability of banks. All these suggest that a highly leveraged bank balance sheet should be helpful for the role of banks as financial intermediaries and liquidity providers in the economy.

However, the equity capital of banks is also recognized as an important resource when it comes to absorbing risks, in particular the idiosyncratic type of risks (see, e.g., Froot and Stein 1998 and Diamond and Rajan 2000). Banking theories posit that the risks associated with the loans to borrowers consist of two parts, systematic risks such as interest rate risks and idiosyncratic risks such as credit risks. The former is thought to be well understood by the market and therefore can easily be laid off by the available financial instruments such as futures or other types of hedging products. These products are also considered fairly priced since the markets these instruments are traded in are fairly liquid in general. The result on capital structure is that no equity capital is necessary to absorb this kind of risks. The idiosyncratic type of risks however cannot be easily communicated to the general market. Within this category are the risks of a borrower to default or to be downgraded. The knowledge about these risks can only be accumulated by banks in the course of interacting with the borrowers for issuing and monitoring loan contracts. Consequently, no fairly priced hedging instrument is available in the market that allows banks to lay off this type of risk as outsiders have no access to the knowledge about the borrowers that the bank privately acquired over time. The market for credit risk-related derivatives is also considerably less liquid in that most such derivatives are custom-made contracts (OCC 2005). It is worth noticing that these outsiders also include the depositors who are not involved in the day-to-day operations of the banks and hence also have no knowledge about the (change in) quality of the borrowers. As a result, the bank must hold capital of its own to prepare for the event, for example, when the borrowers have temporary difficulties in meeting the loan repayment but are expected to improve and be able to repay the loan and interests in the future. In such an event, the loan has positive net present value to the bank, but the depositors, with no knowledge about the quality of the borrower or/and nature of its business, would not be able to judge the viability of the borrower and hence will withdraw their deposits. The bank would only be able to exploits its experience and realize the benefits thereby if it has capital of its own. Here the role of equity capital is crucial in keeping the borrowers afloat and in allowing the bank to benefit from its knowledge about the borrowers. However, as maintained by Diamond (1984) and Diamond and Rajan (2000), equity capital should be kept at the minimum level mainly for two reasons. First, idiosyncratic risks can be substantially reduced by diversification. Second, excessive amount of equity capital will allow the bank to withhold profit it earns from the borrower or to ask a bigger share of the profit *ex post* from the depositors, thereby giving rise to the agency problem between the bank and the depositors. The bottom line is that equity capital is beneficial, but too much of it would be counter-productive.

Equity capital also has the function in mitigating the liquidity risks intrinsic in the banking operation. Here liquidity risk arises when the borrowers and the depositors need funding at the same time and consequently cannot be both honored had the bank been financed entirely by deposits, in which situation, the depositors will get their deposits back but the borrower will lose its funding. Equity capital can serve as a buffer in situations like this and satisfies the liquidity needs on both sides of the balance sheet. It is worth mentioning that liquidity risk differs from the idiosyncratic risk sketched above as it does not involve any difference in opinion regarding the unobservable risks of the borrower. Liquidity risk merely arises as a consequence of the timing of the liquidity needs by both the borrowers and the depositors. Kashyap et al (2002) and Gatev and Strahen (2005) show that banks can utilize their equity capital, among other instruments, in fulfilling the liquidity needs on both sides of their balance sheet.

To summarize the above, leverage has some direct implications on the performance of banks. On the one hand, from the perspective of the depositors and the economy in general, a highly leveraged bank capital structure, or a bank capital structure that is primarily composed with deposits, is beneficial to the profit appropriation by depositors and the liquidity creation and financial intermediation functions of banks. In this aspect, a fragile bank capital structure ensures the relevance of banks in the economy and in turn their long term viability. On the other hand, from the perspective of the owners or shareholders of banks, equity capital creates buffers against unexpected credit or liquidity risks and also enhances the bargaining power of the shareholders in profit sharing. All these advantages however come at the cost of heightened agency problem with the depositors, which makes it more likely for depositors to run on the bank every time the bank attempts to withhold effort or profit. The asset pricing implication of these competing roles of equity capital in banking theories remains an empirical question. How desirable bank shares are to investors conditioning on the leverage of banks could conceivably depend on how necessary the equity capital is to risk mitigation and profit appropriation. In this sense there may be a negative relationship between bank stock returns and leverage as higher leverage increases bank risks and reduces bank's bargaining power in profit sharing. On the flip side, equity capital not only is a more expensive source of financing than deposits but may trigger the run by depositors. As shareholders can benefit from lower equity capital ratio in this argument, there would be a positive relationship between bank stock returns and leverage. Finally, a non-linear relationship is also conceivable with bank stock returns being optimized at certain levels of leverage.

In this paper, we will use several alternative measures to proxy leverage. First, we use as the most straightforward form of leverage the ratio of total equity to total assets[2]. The assumption here is that all non-equity claims on the bank constitute to leverage. Second, we take into account the Basel II capital regulation framework that also treats time deposits as qualified cushion against risks (see, e.g., Saunders and Cornett 2005). The rationale is that time deposits cannot be withdrawn quickly and in many cases without penalty charge by the depositors. Such restrictions substantially reduce the willingness of the owners of time deposits to run on the bank. In our second leverage measurement, we exclude time deposits from total liability and calculate the ratio of the remaining amount of liabilities to total assets. Next, we take the consideration of the Basel II capital regulation framework one step further and measure leverage as the ratio of tier 1 capital to total risk weighted assets (RWA). In so doing, we explicitly take into account the risk profiles of the components of balance sheet as specified by Basel II regulation. In the spirit of Basel II, the gross ratio of total liabilities to total assets is not sufficiently informative once the different levels of risk associated with different financial claims are considered. In the asset part of bank balance sheet holdings such as U.S. government bills carry no credit and liquidity risks as they can be easily liquidated at fair prices. Hence, banks' holding of these securities do not add to the burden on equity capital when anticipating the unexpected needs for cash due to liquidity or credit risks. Therefore, U.S. government securities do not contribute to RWA. On the other hand, loans to small-medium sized enterprises (SMEs) and certain derivative products expose the banks to at least the

[2] Strictly speaking, our proxy for leverage is in fact a measure for capital strength. But a high capital ratio is the same as a low leveraged balance sheet, and vice versa.

outstanding amount. These assets carry 100% or more weight in calculating RWA. The same principle is also used when considering the equity part of bank balance sheets. In this third leverage measurement, we include only Tier 1 capital in considering the degree of leverage of a bank. Equity capital including preferred shares and retained earnings are the primary component of Tier 1 capital as they are the least senior claims against the bank and their holders are the first to be wiped out in case of insolvency. Hence Tier 1 capital is usually thought of as the core capital of banks. In our last leverage measurement, we also consider RWA but use total risk capital, which in addition to Tier 1 core capital also includes qualified liabilities such as the time deposits mentioned above. As it turned out and will be discussed more in depth later, it is the most straightforward measurement of leverage, i.e., the simple ratio of total equity to total assets, that demonstrate the most visible and monotonic relationship with bank stock returns. There is a clear positive (negative) association between bank stock returns and leverage (level of equity capital). This implies that the shareholders of bank stocks value a more fragile bank capital structure or they dislike the use of more equity as a more expensive source of financing.

The second pricing factor we analyze is beta. In the framework of Fama and French (1992), beta, though finally shown to be negligible in pricing the stocks of non-financial firms, is considered a fundamental pricing factor to start with and receives extensive treatment and examination. Probably because beta is shown to have indiscernible implications for asset pricing in non-financial sectors, later efforts in the financial sectors generally exclude beta from their radar (see e.g., Barber and Lyon 1997, Cooper et al 2003, and Viale 2009). Therefore, there has not been any evidence that substantiates or documents the relationship between beta and bank stock returns, existent or otherwise. In this paper, we follow the procedures of Fama and French (1992) to systematically investigate the relationship between beta and bank stock returns. We document a wide spectrum of betas among bank stocks ranging from much higher than one to negative. Correspondingly there is a convex relationship between beta and bank stock returns with the stock returns initially dropping as beta decreases but picking up again when beta approaches zero and becomes negative[3]. Our findings complement Fama and French in the banking sector and suggest the classical relationship between beta and stock returns may be relevant to bank stocks.

[3] This evidence to some extents supports the classical asset pricing theories of Sharpe (1964), Lintner (1965), and Black (1972) that beta is an important determinant of the cross-section of stock returns. However, unlike these theories that predict a positive and linear relationship between beta and stock returns our finding suggests a convex relationship. In a sense, our finding is consistent with Markowitz (1959) in that stocks with negative beta offer stronger diversification potential and therefore are more valuable to the investors.

Size is the third variable we investigate. In the non-financial context of Fama and French (1992), size is shown to have important asset pricing implications. From the banking theories reviewed above, it is conceivable that size has some implications on bank performance that is different from non-financial firms. In particular, Diamond (1984) and Froot and Stein (1998) point out the importance of diversification in bank capital management as well as risk management. In these theories, banks should hedge their exposures to systematic risks such as interest rate or exchange risks by means of financial instruments such as derivatives. As to idiosyncratic risks that no derivatives can perfectly eliminate, banks should resort to diversification for minimizing these risks. Intuitively, the source of diversification can come from expanding the scope of bank operation in terms of geography, demography and/or offered product/services. All these possible sources of diversification naturally lead to a larger bank balance sheet and thereby increase the size of the banks.

Therefore, it may be straightforward to hypothesize that larger banks are more advantageous than their smaller counterparts to weather unexpected losses from those idiosyncratic risks. If so, the size premium observed by Fama and French (1992 and 1993) would be reversed in the banking industry as larger banks benefits from stronger diversification capabilities while holding all else equal. However, Laeven and Levine (2007) cast doubt on the benefit of diversification by banks. They empirically demonstrate that there is actually a diversification discount in financial conglomerates meaning that the sum of multiple activities in one such conglomerate is worth less than the sum of these individual activities left alone. The implication of this finding on bank stock returns would then be the opposite of the size premium hypothesis based on the diversification theory. We would expect a size discount that penalizes banks with bigger size. In this paper, we try to clarify the contradictory hypotheses from these different streams of literature.

We investigate the relationship between bank size and their stock returns and considered two alternative measures of size, total market capitalization and total assets. The use of former is meant to compare with the findings by Fama and French (1992) in the non-financial sectors and Barber and Lyon (1997) in the financial sectors even though we have no prior reason to believe that market capitalization is a better proxy for a bank's capability of diversification then total assets. We therefore also use total assets in our analysis. A measurement such as total assets that signals the overall level of activities might be a better proxy for the level of diversification by banks. As it turned out, total assets is a much stronger explanatory variable than market capitalization in predicting bank stock returns and the predicting relationship is significantly negative, in favor of the diversification discount hypothesis.

In addition to the aforementioned potential pricing factors, we also investigate the ratio of book equity to market equity (BE/ME) and earnings per share (E/P). These variables have been documented in the earlier literature as having important asset pricing implications for both non-financial firms and financial firms (see, e.g., Fama and French 1992 and 1993, Barber and Lyon 1997, and Cooper et al 2003). However we must admit that we are not aware of a solid theoretical foundation in the banking literature on which these variables could be expected to play a role on the performance of banks. Therefore, these variables are treated as control variables in our regressions.

It is worth emphasizing at this stage that our aim in this paper is to find potential pricing factors for bank stocks from existing banking theories and to empirically test their performance with real data using a well-established methodology for studying the cross-section of stock returns. This aim obliges us to focus our attention on two major areas. First, we focus on those variables that are central in the banking literature and have conceivable implications on bank performance. Leverage and size fall into this group while BE/ME, E/P and even beta do not. Second, we focus on those variables that are likely to be relevant to a majority of banks rather than a limited subset. In other words, the chosen variables should be available for most banks and years in our sample. The reason for this focus is our desire to draw some conclusions on the pricing of the banking sector in general rather than a selected group. The implication of this focus is that we do not include such variables as the use of derivatives, off-balance sheet assets or income, and hedging related instruments. These activities are likely to be present in and relevant for a small subset of banks, most likely the largest banks, and can hardly be considered universal pricing factors for all (listed) banks.

### 2.3 Portfolio formation

In this section, we describe the procedures we use for forming the portfolios of bank stocks. We collect the stock holding period return data from CRSP for non-governmental depository institutions only, i.e., companies whose first three digits of SIC code are 602, 603, 606, 608 , 609 and 671. From CRSP we also retrieve the number of shares outstanding and the per share price in order to calculate market capitalization. We collect from Compustat the data of such variables as total assets, total equity, and E/P. To complement Compustat, we also add the data related to risk-adjusted variables such as tier 1 capital, total risk capital and RWA found in the Y9-C report database for bank holding companies maintained by the Federal Bank of Chicago.

With these three data sources, we also face three different data frequencies. While CRSP and Compustat data items are available on a monthly and annual frequency respectively, the Y9-C report data is updated every quarter. As a result, we must form and reconstruct portfolios based on potential pricing factors that have different frequency of observations.

We essentially form and reconstruct the portfolios on a monthly basis. In a given month, whether or not the portfolios are reassembled based on certain bank characteristics depend on the source of data of those characteristics. Variables from CRSP are available monthly and hence allow us to reconstruct the portfolios every month based on the variables available there. Every month, all pricing factors that have CRSP's monthly data element are updated using the value of the previous month and the portfolios are reconstructed using this updated value. For example, the BE/ME ratio has two elements, the BE part is retrieved from Compustat and therefore remains the same for a year. The ME part however is updated monthly to reflect the new stock price and number of shares outstanding in the last month. In turn the portfolios are reconstructed according to this updated BE/ME ratio. The variables from the Federal Reserve Bank of Chicago only have quarterly frequency. Therefore, the reconstruction of the portfolio based on variables from the Y9-C Report is carried out every quarter based on the value of the previous quarter. This means if in a month both Compustat/CRSP and Federal Reserve updates are available, the reconstruction of the portfolios takes into account all variables. If however in a month only the Compustat/CRSP update is available, the portfolios are reconstructed based only on the Compustat/CRSP update.

As far as Compustat data is concerned, like Fama and French (1992) we allow for six months between the construction of the portfolio and the recording of the bank stock returns so that our procedures resemble real-time portfolio constructions. For the Y9-C report data, we allow an interval of a quarter between forming the portfolio and the recording of the stock holding period return. In other words, in a give month the stock return is associated with the Compustat data six month ago, CRSP data of the previous month, and the Y9-C report data of the previous quarter. In the same quarter the value of the variables from the Y9-C report remain the same. In the first month of the quarter, the portfolios are reconstructed using the previous quarterly Y9-C Report. The six month lag applied to Compustat data is known to be reasonable and conservative enough in terms of data availability for real-time portfolio formation. The quarterly lag for using the Y9-C report should also be sensible because the update normally happens in the second month of a quarter.

Unlike Barber and Lyon (1997) who form portfolios based on the cutoff points created from the nonfinancial firms and then place both financial and non-financial stocks in these portfolios and then keep only the financial stocks in the final dataset, we form portfolios purely based the cutoff points created from the selected banking firms. The rationale behind this procedure is that the financial analysts who follow these stocks are more likely to do so in the context of this particular industry or sector. It is a standard practice in the financial analysis industry that firms or stocks of a particular industry are assigned to specialized analyst, which implies banking stocks are followed and analyzed with other banking stocks. Therefore, portfolios formed on the basis of banking stocks alone should be more reasonable and closer to actual business practice for the analysis of bank stock returns.

### 2.4 Preliminary analysis on bank stock returns and bank characteristics: one-way sort

In this section we describe the pattern of bank stock returns over the rankings of bank characteristics. We form five portfolios based on the chosen bank characteristics of the previous month and calculate the average excess return of the portfolios in the following month. The number of portfolios we form is less than Fama and French (1992) and Barber and Lyon (1997). This choice is justified by our much smaller sample than the earlier studies. To maintain a reasonably sizable sample size within each portfolio, we inevitably must opt for a smaller number of portfolios (see, e.g., Viale et al 2009 for the same choice). The average returns of the rank-based portfolios are then calculated month by month and for all available months. Similar to Fama and French (1992) the bank stocks in a characteristics-rank portfolio in a given month are not necessarily the same as in other months. The ranking of the stocks based on the chosen characteristics can vary from month to month, which may move certain stocks among portfolios.

#### 2.4.1 Leverage

Table I reports the average excess returns of portfolios of bank stocks formed on four measures of leverage. The first two nominal leverage measures are calculated directly from bank balance sheet value of total equity, time deposits and total assets. A smaller ratio of total equity to total assets implies a high leverage, and vice versa. The second nominal leverage measure treats time deposits as equity and thereby producing a series of smaller leverage measure compared with the first leverage measure that consists of only equity.

**Table I**
**Average bank stock returns for portfolios formed on nominal or risk-adjusted leverage measures: January 1987 to December 2007**

Portfolios are formed every month based on the most recently available information for each of the leverage ratios. The mean excess stock return is calculated by subtracting the one-month Treasury bill ratio from the monthly holding period return from CRSP; Total equity, time deposit and Total assets are collected from Compustat; all data items for the two risk adjusted leverage ratios are from the Y-9C Report of bank holding companies maintained by the Federal Reserve Bank of Chicago. The sample period is from January 1987 till December 2007. Leverage 1 is the ratio of total equity to total asset with a high ratio signaling low leverage and vice versa. Leverage 2 is similar with Leverage 1 but treats time deposits as equity. Risk adjusted leverage 1 and 2 use Tier 1 capital and total riskcap (total risk capital) divided by RWA (risk weighted assets) respectively to measure the degree of bank leverage.

| | Low | 2 | 3 | 4 | High | | Low | 2 | 3 | 4 | High |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Leverage 1** | | | | | | **Risk adjusted leverage 1** | | | | |
| Total equity/Total assets | 0.12 | 0.10 | 0.09 | 0.08 | 0.06 | Tier1/RWA | 0.19 | 0.13 | 0.12 | 0.10 | 0.09 |
| Mean excess return (%) | 0.46 | 0.48 | 0.56 | 0.62 | 1.00 | Mean excess return (%) | 0.49 | 0.67 | 0.51 | 0.94 | 0.48 |
| Beta | 0.69 | 0.56 | 0.49 | 0.46 | 0.38 | Beta | 0.63 | 0.54 | 0.49 | 0.48 | 0.44 |
| Size:Ln(TA) | 19.53 | 19.94 | 19.57 | 19.52 | 19.19 | Size:Ln(TA) | 20.77 | 19.76 | 19.33 | 19.17 | 18.75 |
| BE/ME | 0.49 | 0.48 | 0.54 | 0.56 | 0.61 | BE/ME | 0.49 | 0.46 | 0.50 | 0.56 | 0.67 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| E/P | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | E/P | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 |
| Number of observations | 4,129 | 4,119 | 4,126 | 4,071 | 4,064 | Number of observations | 4,133 | 4,110 | 4,087 | 4,108 | 4,064 |
| Number of banks | 176 | 206 | 225 | 203 | 171 | Number of banks | 161 | 207 | 224 | 212 | 168 |
| | **Leverage 2** | | | | | | **Risk adjusted leverage 2** | | | | |
| (Total equity+time deposit)/Total assets | 0.57 | 0.47 | 0.41 | 0.35 | 0.24 | Total riskcap/RWA | 0.20 | 0.15 | 0.13 | 0.12 | 0.11 |
| Mean excess return (%) | 0.43 | 0.57 | 0.73 | 0.73 | 0.64 | Mean excess return (%) | 0.48 | 0.64 | 0.54 | 0.57 | 0.87 |
| Beta | 0.69 | 0.56 | 0.49 | 0.46 | 0.38 | Beta | 0.58 | 0.56 | 0.54 | 0.46 | 0.44 |
| Size:Ln(TA) | 21.22 | 19.61 | 19.40 | 19.09 | 18.44 | Size:Ln(TA) | 19.91 | 20.11 | 19.68 | 19.28 | 18.79 |
| BE/ME | 0.43 | 0.52 | 0.53 | 0.59 | 0.61 | BE/ME | 0.48 | 0.48 | 0.50 | 0.54 | 0.67 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| E/P | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 | E/P | 0.05 | 0.06 | 0.06 | 0.06 | 0.07 |
| Number of observations | 4,095 | 4,080 | 4,078 | 4,077 | 4,043 | Number of observations | 4,129 | 4,108 | 4,094 | 4,110 | 4,061 |
| Number of banks | 191 | 207 | 198 | 214 | 165 | Number of banks | 174 | 210 | 232 | 236 | 204 |

In the risk-adjusted leverage measures, we use the risk-weighted capital or assets that are calculated using the Basel II weighting scheme. As explained in the literature review part, all these leverage ratios from different angles measure the extent to which a bank is geared up or, in other words, how strong the bank's capital base is. Table I shows that there is a clear monotonically negative relationship between equity capital ratio and stock returns for the first leverage ratio. In other words, the relationship between the first leverage measurement and the excess stock returns is clearly positive. As banks equity ratio decreases or leverage increases, bank stock returns become higher, and vice versa. Such a relationship seems to suggest that bank stock investors consider highly leveraged banks more valuable than the banks holding more equity. It can also suggest that banks that use their equity capital more efficiently, signaled by the amount of asset they can maintain for a given amount of equity capital, are expected to be more profitable. Therefore, in light of the financial crisis of the 2008/2009 period and the exploding leverage experienced by many banks prior to the crisis, our finding suggests the market has imprudently rewarded and in turn exacerbated banks' use of more leverage. Arguably, for quite some time prior to the crisis, investors considered high leverage as a sign of efficiency and earning power instead of potential vulnerability in times of financial distress. The second leverage measurement however does not offer a clear ordering of bank stock returns that follows the order of the leverage ratio. This means in the eyes of banks stock investors time deposits are not considered the equivalent of bank equity capital that can compensate or substitute bank capital base.

If we measure leverage using the ratio of risk capital to risk weighted assets (RWA), the relationship with bank stock returns is not clear. The average excess stock returns do not rise or fall monotonically with the risk-adjusted leverage ratios. Under Basel II regulation, banks capital ratio is not calculated using book value directly. Instead different weights are applied to different assets. For example, risk free assets such as U.S. government securities carry zero weight and hence do not contribute to RWA. Equity investments however are considered risky and the whole amount is included in RWA. In the middle range, there are bonds from well-established and financially sound corporations and government securities from other countries that contribute to RWA with different percentage of scaling, which range between zero and one. Similar with the asset side of the balance sheet, on which RWA is calculated, the items on the liability side of bank balance sheet are also classified according to their risk profile and given different weights for calculating the amount of risk capital. The risk profile in this situation is to measure how senior the liability claims are. For example, equity capital is the most heavily weighted (100%) because equity is the least senior among all the financing sources of a bank, which means in times of financial distress or bankruptcy, equity investors are the first to absorb the losses. Next in line are the preferred stocks, which suffer losses after the common equity is wiped out but before creditors take the cut. Liquid deposits such as demand deposits are not considered banks' capital because they can be withdrawn from the banks very quickly and therefore cannot be expected to absorb any losses the banks may incur. After weighing and summing up all balance items in this way, the risk-adjusted leverage of a bank can be calculated by dividing risk-weighted capital by RWA. Our tabulation from the one-way sort shows that in general bank stock returns also increases as banks' risk-weighted leverage decreases. In other words, banks that have more risky assets relative to their risk-weighted capital are more valuable to investors. However, as can be seen in the last portfolio formed on the first risk-adjusted leverage measure, when leverage becomes sufficiently high, which is signaled by the low risk adjusted capital ratio, stock returns decreased. This implies that contrary to the crude equity capital ratio investors consider a low risk-adjusted capital ratio a sign of weakness and vulnerability.

### 2.4.2 Beta

Unlike most existent literature, we also investigate the relationship between beta and bank stock returns. Even though Fama and French (1992) in the context of non-financial stocks cast severe doubt on the traditional thoughts that there ought to be a strong and positive relationship between stock returns and the beta of the stock, no literature has investigated if the preposition still holds in bank stocks. Barber and Lyon (1997), Cooper et al (2003), and Viale et al (2009) all assume that the absence of beta-return association found by Fama and French (1992) also holds in banking or financial stocks and did not attempt to examine beta. In this paper, we investigate the validity of this assumption. We follow the methodology of Fama and French in estimating beta. Specifically, for each bank stock we regress the monthly excess stock returns of the past two years on the market return of the same period and with one month lag. The sum of the coefficients is our beta estimate of the stock. The regression on both the current and one-month lagged market return is meant to adjust non-synchronous trading as in Fama and French (1992). The beta estimate is then used for portfolio formation of the next month. The averages of these stock level pre-ranking betas of the portfolios are reported in Table II Panel A with the corresponding mean excess return of the portfolios.

It is interesting to notice the average portfolio beta moves from 1.13, implying a very sensitive response to the general market returns, to -0.07, implying a negative co-movement with the market. In other words, there are bank stocks that move in the same direction with the market when some other bank stocks move almost independently with the market. In the view of Sharpe (1964), Lintner (1965), and Black (1972), stock returns are expected to follow the size of their betas with high beta being accompanied with high returns and vice versa. The relationship between beta and bank stock returns as we show here does not follow such a monotonically increasing or decreasing pattern. Our finding is also distinct from Fama and French (1992) in the non-financial sector that stock returns do not respond to beta in the sense that stock returns are flat across the portfolios formed on beta. What we can observe seems to be a nonlinear and convex relationship between bank stock returns and their betas.

**Table II**
**Average bank stock returns for portfolios formed on Pre-ranking beta and size: January 1987 to December 2007**

Portfolios are formed every month based on the most recently available information for each ranking variable. The mean excess stock return is calculated by subtracting the one-month Treasury bill rate from the monthly holding period return from CRSP; pre-ranking beta is portfolio-level average sum of coefficients in the regressions of the excess bank stock returns on the current and past month's excess market returns proxied by S&P500 index; Size portfolios 1 are based on the natural log of Total assets, collected from Federal Reserve Bank of Chicago Call Report; Size portfolios 2 are based on the natural log of bank market capitalization calculated by multiplying share price by number of shares outstanding, both of which are collected from CRSP. The sample period is from January 1987 till December 2007.

| | Low | 2 | 3 | 4 | High |
|---|---|---|---|---|---|
| | **Panel A: Beta portfolios** | | | | |
| Pre-ranking Beta | -0.07 | 0.25 | 0.46 | 0.69 | 1.13 |
| Mean excess return (%) | 0.75 | 0.51 | 0.48 | 0.57 | 0.80 |
| Size:Ln(TA) | 18.70 | 19.11 | 19.55 | 19.86 | 20.53 |
| BE/ME | 0.57 | 0.57 | 0.53 | 0.53 | 0.49 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| E/P | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Number of observations | 4,073 | 4,116 | 4,130 | 4,121 | 4,069 |
| Number of banks | 181 | 206 | 255 | 240 | 154 |
| | Small | 2 | 3 | 4 | Big |
| | **Panel B: Size portfolios 1** | | | | |
| Ln (Total assets) | 17.60 | 18.44 | 19.21 | 20.20 | 22.34 |
| Mean excess return (%) | 0.84 | 0.74 | 0.85 | 0.38 | 0.30 |
| Beta | -0.01 | 0.28 | 0.48 | 0.71 | 1.12 |
| BE/ME | 0.74 | 0.59 | 0.50 | 0.46 | 0.39 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| E/P | 0.05 | 0.07 | 0.06 | 0.06 | 0.06 |
| Number of observations | 4,054 | 4,120 | 4,129 | 4,130 | 4,076 |
| Number of banks | 161 | 207 | 224 | 212 | 168 |
| | **Panel C: Size portfolios 2** | | | | |
| Ln (Market capitalization) | 12.69 | 13.38 | 14.05 | 14.90 | 16.98 |
| Mean excess return (%) | 0.69 | 0.75 | 0.78 | 0.63 | 0.27 |
| Beta | 0.31 | 0.31 | 0.56 | 0.65 | 0.74 |
| BE/ME | 0.63 | 0.60 | 0.53 | 0.48 | 0.44 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| E/P | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 |
| Number of observations | 4,013 | 4,111 | 4,127 | 4,108 | 4,150 |
| Number of banks | 174 | 210 | 232 | 236 | 204 |

As beta decreases, stock returns initially also follow the drop and in this sense partially comply with the prediction of Black, Sharpe and Lintner. But after beta drops to a certain level, in this case after the third beta portfolio, stock returns start to pick up again and end up in the last portfolio at a level comparable with the first beta portfolio. Such a convex pattern may imply that bank stocks that are very irresponsive to the general market or show negative response to the market offer diversification potential for investors in their own constructions of portfolios.

As a result, these stocks are traded at a premium over stocks that have only medium level betas. Effectively, the convex pattern between beta and bank stock returns also suggests that for bank stocks the positive relationship between beta and stock returns predicted by Sharpe (1964), Lintner (1965), and Black (1972) seems to hold for bank stock with high to medium level betas. But the reverse of Sharpe (1964), Lintner (1965), and Black (1972) holds for bank stocks with medium to negative betas.

We showed in Table I that there seems to be a strong monotonically increasing relationship between bank leverage and bank stock returns. To cast away the doubt that our finding of a convex relationship between beta and returns has something to do with bank leverage, we estimate post-ranking bank stock betas for each leverage portfolios. Specifically, after forming the portfolios based on leverage each month, we record the bank-level monthly excess return of the 5 leverage portfolios for the rest of the sample period. The "post-ranking" return series are then used in the regressions on the contemporary and lagged market excess returns. The sum of the coefficients becomes the post-ranking beta of the individual bank stocks. The individual bank betas within each leverage portfolios are then further ranked into 5 groups and averaged. Our procedure for estimating the post-ranking beta is essentially the same as Fama and French (1992). These average betas are reported in Table III. As can be seen in Table III, the order of the pre-ranking beta is almost perfectly replicated with the post-ranking beta portfolio formation. Within each leverage portfolio, the average post-ranking beta of the beta-ranked portfolios almost always follows the order of the pre-ranking betas. This means that the convex relationship between beta and excess bank stock returns is independent of any effect of leverage on the return series. Later on, we will assign these post-ranking betas to the individual stocks in a portfolio and use these betas in regression analysis.

### 2.4.3 Size

In Table II Panel B and C, we also report the average returns of the portfolios formed on two alternative size measurements, total assets and market capitalization, respectively. There seems to be a negative relationship between market capitalization and stock returns though the relationship is not completely monotonic. Excluding the third rank portfolio, there is a clear increasing trend in stock returns as we move from large to small banks. The third rank portfolio however has the highest average return of all five portfolios. This might suggest that in the eyes of bank stock investors, small banks are generally more favorable while medium sized banks are the most attractive. More specifically, stock returns do not seem to monotonically increase as the average size of the banks in a portfolio, measured by market capitalization, decreases. Similar pattern can also be observed had we used the book value of total assets as size factor. What seems to be the case is that stock returns initially increase as we move to smaller banks, but decrease for banks that are sufficiently small.

**Table III**
**Post-ranking betas of portfolios formed on pre-ranking beta and leverage**

This table reports the average beta of portfolios formed on pre-ranking beta and leverage. The portfolios are reconstructed monthly. The beta is calculated at the individual stock level, which is the sum of coefficients of the regression of the bank stock excess return in the month after the portfolio formation on the excess market return of the current and the previous month. The market return is proxied by the S&P500 index.

| Ranking by | Ranking by pre-ranking beta | | | | |
|---|---|---|---|---|---|
| Leverage | Low | 2 | 3 | 4 | High |
| Low | 0.11 | 0.24 | 0.51 | 1.03 | 1.33 |
| 2 | 0.01 | 0.31 | 0.52 | 0.85 | 1.17 |
| 3 | -0.05 | 0.26 | 0.44 | 0.79 | 1.01 |
| 4 | -0.07 | 0.19 | 0.41 | 0.62 | 0.87 |
| High | -0.12 | 0.08 | 0.39 | 0.54 | 0.93 |
| All | -0.02 | 0.22 | 0.45 | 0.77 | 1.06 |

| Ranking by | Ranking by pre-ranking beta | | | | |
|---|---|---|---|---|---|
| Size | Low | 2 | 3 | 4 | High |
| Small | 0.01 | 0.27 | 0.49 | 0.61 | 0.88 |
| 2 | -0.05 | 0.28 | 0.47 | 0.61 | 0.92 |
| 3 | -0.04 | 0.29 | 0.47 | 0.79 | 1.07 |
| 4 | 0.02 | 0.26 | 0.49 | 0.74 | 1.2 |
| Big | 0.11 | 0.33 | 0.48 | 0.7 | 1.13 |
| All | 0.01 | 0.29 | 0.48 | 0.69 | 1.04 |

This pattern of stock returns to size may be explained by the diversification discount observed in large financial conglomerates by Laeven and Levine (2007) where it is shown that the combined value of these large financial institutions worth less than the sum of the value of their constituent parts. As this diversification discount is likely to decrease with bank size, smaller banks' higher return than their larger counterparts may be explained by the smaller discount applied to them. However, as banks become too small, the concern over their viability during distress may dominate the decrease in diversification discount, and hence their stock returns are reduced by this stress related discount.

### 2.4.4 Other pricing factors

Up till now, we have focused on the potential pricing factors of bank stocks that can be extracted from the existing banking literature. We also control for a couple of other pricing factor that have been found to be important for explaining the stock returns of non-financial firms. In particular, we include earnings per share (E/P) ratio and the ratio of book equity to market equity (BE/ME). Both variables can and have been interpreted as proxies for growth potential. High E/P ratio, or a relatively low stock price compared to the earning, implies a low growth potential. Conversely, a low E/P ratio, which implies that investors are willing to pay more for the stock than what the current earning warrants, signals a high growth potential. BE/ME has similar interpretations. For comparable levels of book equity, a high BE/ME ratio means that investors consider the firm less promising in the future and less valuable as time passes by, which is reflected in the low market value of the equity, than firms with low BE/ME ratio as the current market value should be discounted future cash flow of the firm/stock.

Table IV demonstrates the average E/P and BE/ME ratios for the portfolios and their corresponding average excess stock returns. The relationship between the ranking of earnings per share (E/P) and average stock returns resembles very closely a monotonically positive relationship. This is hardly surprising as the earning power per share of stocks is part of the total return of the stocks and therefore highly positively correlated with the returns themselves. We can also interpret high (low) E/P as low (high) growth prospect. Then the positive relationship between E/P ratio and bank stock returns says that investors in bank stocks resemble those in utility industries who appreciate the value of the stocks rather than their growth opportunities. The positive relationship between E/P and stock returns is also strong and robust in Fama and French (1992) and Barber and Lyon (1997).

The assertion that bank stocks appear to be value stocks can also be seen in the response of stock returns to BE/ME ratio. Even though the picture is not as monotonic as for E/P ratio, the general trend is that as BE/ME ratio increases, signaling less growth opportunity, stock returns also increase, and vice versa. However, it is worth emphasizing that the relationship between bank stock returns and E/P as well as BE/ME ratios have no roots in the banking theories. Rather they are simple extracted from the asset pricing literature originated from the non-financial sectors. In our later regression models, these ratios will enter the equations as control variables.

**Table IV**
**Average bank stock returns for portfolios formed on E/P and BE/ME ratios: January 1987 to December 2007**

Portfolios are formed every month based on the most recently available information for earnings per share (E/P) ratio and book value of equity to market value of equity (BE/ME) ratio. The mean excess stock return is calculated by subtracting the one-month Treasury bill ratio from the monthly holding period return collected from CRSP; market value of equity is calculated as stock prices multiplied by number of shares outstanding, both come from CRSP; per share earnings and book value of equity are collected from Compustat. All data items are of monthly frequency. The sample period is from January 1987 till December 2007.

| Ranking | Low | 2 | 3 | 4 | High |
|---|---|---|---|---|---|
| | **Earnings per share portfolios** | | | | |
| E/P | 0.02 | 0.05 | 0.06 | 0.07 | 0.09 |
| Mean excess return (%) | 0.75 | 0.73 | 0.66 | 1.11 | 1.29 |
| Beta | 0.58 | 0.52 | 0.50 | 0.48 | 0.49 |
| Size | 19.66 | 19.73 | 19.65 | 19.51 | 19.19 |
| BE/ME | 0.47 | 0.47 | 0.49 | 0.54 | 0.72 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Number of observations | 4,072 | 4,116 | 4,127 | 4,123 | 4,071 |
| Number of banks | 193 | 214 | 220 | 181 | 207 |
| | **Book equity to market equity portfolios** | | | | |
| BE/ME | 0.29 | 0.41 | 0.50 | 0.60 | 0.89 |
| Mean excess return (%) | 0.79 | 0.67 | 0.66 | 1.29 | 1.13 |
| Beta | 0.64 | 0.54 | 0.50 | 0.45 | 0.45 |
| Size | 20.76 | 20.12 | 19.57 | 19.00 | 18.30 |
| E/P | 0.05 | 0.06 | 0.06 | 0.07 | 0.07 |
| ROA | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Number of observations | 4,080 | 4,123 | 4,125 | 4,121 | 4,060 |
| Number of banks | 189 | 196 | 235 | 228 | 211 |

### 2.4.5 Summary of the above portfolio analyses

The analyses presented till now have shown some quite distinct features of bank stock returns that were different from the existing asset pricing literature. We started with the discovery of the potential pricing factors for bank stocks from the banking literature rather than applying what has been found in the nonfinancial world. As a result we have found some pricing factors that were or were not relevant in the nonfinancial context. In particular, we found that the simple leverage ratio seems to be a useful bank characteristic that is monotonically and positively associated with portfolios of bank stock returns. Higher leverage is shown to be strongly and positively associated with bank stock returns, and vice versa. Next, most of the existing literature omit beta from their analysis of bank stock returns because beta was found to be irrelevant as a pricing factor for non-financial stocks. We however demonstrate that beta seems to have a strong non-linear convex relationship with bank stock returns where the highest and lowest betas are associated with comparably high stock returns and mid-level beta portfolios have the lowest stock returns. The relationship between beta and stock returns is also shown to be robust conditioning on leverage and size. Third, unlike in the non-financial world where size is shown to give rise to abnormal stock returns, we cannot see a comparable relationship in bank stocks. In particular, bank stock returns do not seem to respond to the ranking by size, measured by either market capitalization or total assets, in a stylized pattern even though large banks, measured by total assets, are more often associated with lower returns. All these results mean that the direct application of findings in the non-financial sectors in banking stocks cannot be fully justified and our focus on the banking sector alone contributes some sector-specific insights that are likely to be more important to the analysis of stock returns of this particular industry. In what follows, we carry out regression analysis that investigates bank stock returns in a univariate and multivariate context.

### 2.5 Regression analysis

In our regression analysis, we model bank stock excess returns using a variety of model specifications and different combinations of explanatory variables, which as mentioned before are specifically extracted from the banking literature. It is a distinguishing feature of this paper that we do not assume the validity of the asset pricing factors found to be relevant in the non-financial world as in, e.g., Barber and Lyon (1997), Cooper et al (2003), and Viale et al (2009). Instead, we investigate the pricing effect of variables that are hypothesized relevant factors for banks. We report below the outcome of three types of regression models, the Fama-MacBeth style cross-sectional regressions, panel data regressions, and non-parametric regressions that use the percentile ranking of the pricing factors as explanatory variables instead of their values. As will be clear later, our main results are robust and consistent across these different model specifications. In particular, consistent with the portfolio results above, leverage has a significantly positive relationship with bank stock returns; the effect of bank size seems to be significantly negative; beta has a significantly negative first-order effect on bank stock returns but the second-order effect is significantly positive. Despite the fact that the included explanatory variables are almost always statistically significant, the performance of the model is in general less spectacular as they explain only a small fraction of the variations of bank stock excess returns. But the explanatory power of our simpler models is comparable with other models that include more variables and use more elaborate econometric specifications (see e.g., Viale et al 2009).

Table V reports the coefficients of univariate regressions that include one explanatory variable at a time. We estimate four models that examine the leverage measurements we have constructed, two models for beta with beta itself and beta in addition to the square of beta respectively, and two models for size. Among the four leverage proxies, the simple ratio of total equity to total assets has the strongest result although all four proxies demonstrate a negative relationship between bank capital strength and excess stock returns. In other words, leverage has a significantly positive relationship with bank stock returns. This is consistent with what we have shown above with portfolios of bank stocks formed on the ranking of leverage.

**Table V**
**Coefficients of univariate regressions**

This table reports the coefficients and their t-statistics of univariate regressions that separately regresses the excess bank stock returns on leverage, beta, and size. Four leverage measurements are examined: (1) equity/TA is the ratio of total equity to total assets, (2) the ratio of total equity capital plus time deposits to total assets, (3) tier 1 risk capital to risk weighted assets, (4) total risk capital to risk weighted assets. Two models are estimated for beta: the first model includes only pre-ranking beta itself, but the second model also includes the square of the pre-ranking beta. Two models are estimated for size: the first model uses the natural log of total assets while the second model uses the natural log of market capitalization. The level of significance of the coefficients is signaled by the number of stars: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level.

| **Leverage measurements** | | **Beta** | | **Size** | |
|---|---|---|---|---|---|
| Equity/TA | -1.100*** | $\beta$ | -0.571*** | Ln(Total assets) | -0.152*** |
| | (-4.959) | | (-5.928) | | (-4.715) |
| (Equity+time deposit)/TA | -0.990** | $\beta$ | -0.842*** | Ln(Market value) | 0.007 |
| | (-2.282) | | (-5.534) | | (0.221) |
| | | $\beta^2$ | 0.205** | | |
| | | | (2.298) | | |
| Tier 1 capital/RWA | -1.376 | | | | |
| | (-1.129) | | | | |
| Total risk capital/RWA | -0.239* | | | | |
| | (-1.862) | | | | |

In examining the relationship between beta and bank stock excess returns in the context of portfolios above, we have shown there seems to be a convex non-linear relationship between beta and returns. In the univariate regressions, we test the existence of this non-linear relationship by estimating a model with the square of stock post-ranking beta. In Table V, the model that includes only beta renders a significantly negative coefficient for beta implying that the excess returns of bank stock would fall with the rise of beta. This is in contrast to the asset pricing theory of Sharpe-Lintner-Black that predicts a positive relationship. The second beta related model shows that the power of beta has a significantly positive relationship with bank stock returns, which validates our previous suspicion that there is a U-shaped convex relationship between beta and returns. Apparently, the relationship between beta and stock returns for banks is very distinct and more complicated than what has been documented in the non-financial sectors. What Fama and French (1992) found in the non-financial world is the insensitive response of stock returns to beta. For banks however, not only is the pricing relationship between beta and returns strong, but there is a strong non-linear pattern as well. Bank stock returns initially drop with the rise in beta. But the speed of the dropping decreases and, as can be seen in our earlier text, will eventually drive the stock returns upward and to rise with beta.

Market capitalization used to be the proxy for size in the asset pricing literature, for both non-financial stocks (Fama and French 1992 and 1993) and financial stocks (Barber and Lyon 1997, Cooper et al 2003, and Viale 2009). However, in the banking literature, any hypothesis between bank size and bank performance can only be drawn by considering the overall size of the banks. Therefore, we investigate both market capitalization and total assets and their pricing effect on bank stocks. The univariate models in Table V show that while the natural log of total assets is significantly negatively associated with bank stock excess returns, there is virtually no response from the returns to the natural log of market capitalization. This is a rather surprising finding since the correlation between total assets and market capitalization is about 0.96. It is possible that the regressions are influenced by a few extreme values of total assets. However, as we will later show, the negative relationship between total assets and returns will remain statistically strong in the non-parametric models that use the percentile ranking of the bank level total assets as explanatory variables. Therefore, large banks are more likely to have low stock returns, and vice versa.

The univariate regressions point out the important pricing effect of the simple leverage measurement, beta and its power, and total assets. In Table VI, these variables are examined with each other and control variables in multivariate regression models using the Fama-MacBeth (1973) methodology.

**Table VI**
**Average Coefficients of Multivariate Month-by-Month Regressions of bank stock excess returns 1987-2007**

All models are estimated using Fama-MacBeth (1973) regressions. The reported coefficients are the average of monthly regression coefficients from January 1987 to December 2007. The t-statistic in the brackets is the average coefficients divided by their time series standard error. Equity is the total equity capital; TA is the total assets; β is the pre-ranking beta of individual banks stocks estimated by regressing the excess bank stock returns over one month T-bill rate for the past two years on the excess market returns proxied by S&P500 index; E/P is earnings per share and is truncated at zero, i.e., negative earnings are assumed to be zero; BE/ME is the ratio of book equity to market equity. All balance sheet variables are collected from the Federal Reserve of Chicago quarterly Y-9C report, are matched with CRSP stock returns of the next quarter. *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Equity/TA | -5.570** | -5.043** | -6.319*** | -6.679*** | -6.421*** |
| | (-2.21) | (-2.00) | (-2.55) | (-2.66) | (-2.49) |
| β | -0.262*** | -0.419*** | -0.294*** | -0.283** | -0.138** |
| | (-2.51) | (-2.72) | (-2.62) | (-2.14) | (-2.24) |
| $\beta^2$ | | 0.627*** | 0.637*** | 0.676** | 0.440** |
| | | (2.43) | (2.60) | (2.01) | (1.81) |
| Ln (Total assets) | | | -0.150* | -0.141 | -0.249*** |
| | | | (-1.74) | (-1.55) | (-3.02) |
| E/P | | | | 0.603*** | 0.434*** |
| | | | | (9.93) | (7.37) |
| BE/ME | | | | | 0.411*** |
| | | | | | (4.67) |
| Intercept | 1.129*** | 1.179*** | 3.422*** | 2.094** | 2.703** |
| | (2.61) | (2.83) | (2.46) | (1.99) | (2.06) |

In these regressions, we add the candidate explanatory variables one at a time so that the incremental contribution of the added variable can be easily judged. Clearly, the conclusions from the univariate regressions remain robust. The ratio of equity to total assets is always significantly negatively related with bank stock returns, implying a positive relationship between leverage and returns. The convex relationship between beta and returns remains strong as can be seen from the negative coefficient of beta and the positive coefficient of the square of beta, both of which are always statistically significant. Size is always negatively related to returns implying that stocks of larger banks have lower expected excess returns. Earnings per share and the ratio of book equity to market equity enter the equation as control variables. They both are significantly positively related to bank stock returns.

The results in Table VI show that bank stocks seem to be related to a different set of characteristics than non-financial stocks. Specifically, for non-financial stocks as in Fama and French (1992) beta becomes an irrelevant pricing factor after controlling for size. In addition, the relation between leverage and stock returns is absorbed by BE/ME. In our results, the relations between beta, leverage, size, and bank stock returns remain consistently strong irrespective of the conditioning set. In conclusion, beta and leverage, the pricing factors that have been "abandoned" by the literature in non-financial stocks, seem to be important considerations in the examination of bank stocks.

### 2.6 Robustness checks

#### 2.6.1 Alternative Econometric models

In this section we examine the robustness of the results found above by a few alternative regression frameworks. Table VII reports the estimation output from panel data regressions of the bank stock excess returns on various combinations of explanatory variables and bank as well as time fixed effects. As can be seen in Table VII, most of our previous assertions hold up well in panel data regressions in terms of the signs of the coefficients and their level of significance. In particular, the simple leverage measurement is consistently and significantly positively related to bank stock returns. Size is consistently negatively related to returns. The sign of beta is always negative, but the level of significance sometime disappears depending on the conditioning set; the same is also true for the power of beta, which always has positive coefficient and very often significant. Note that the level of significance is consistent in Panel A where time fixed-effects are not controlled for. In Panel B however, the inclusion of year dummies that control for time fixed-effects makes some of the significance disappear. This may imply that the parameters may be time-variant. As we will show in later robustness checks, some coefficients indeed behave differently in different sub-period. But our main results stay intact.

**Table VII**
**Panel data regressions of bank stock excess returns 1987-2007**

This table reports the estimation outcome of fixed effects panel data models. Equity is total equity capital; TA is total assets; β is the pre-ranking beta of individual banks stocks estimated by regressing the excess bank stock returns over one month T-bill rate for the past two years on the excess market returns proxied by S&P500 index; E/P is earnings per share and is truncated at zero, i.e., negative earnings are assumed to be zero; BE/ME is the ratio of book equity to market equity. All balance sheet variables are collected from the Federal Reserve of Chicago quarterly Y-9C report, are matched with CRSP stock returns of the next quarter. In all models bank specific slopes are assumed to be constant across the sample period. In Panel A, time-fixed effects are not considered. In Panel B, year dummies have been used to control for time fixed effects. *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level.

| **Panel A** | | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **Equity/TA** | -0.154*** | -0.154*** | -0.109*** | -0.120*** | -0.114*** | -0.061*** |
| | (-4.783) | (-4.797) | (-4.843) | (-5.306) | (-5.091) | (-2.614) |
| **β** | | -0.698*** | -0.832*** | -0.717*** | -0.779*** | -0.825*** |
| | | (-4.930) | (-5.465) | (-4.626) | (-5.057) | (-5.298) |
| **$β^2$** | | | 0.185** | 0.177** | 0.198** | 0.240*** |
| | | | (2.076) | (1.981) | (2.235) | (2.695) |
| **Ln (TA)** | | | | -0.128*** | -0.115*** | -0.219*** |
| | | | | (-3.776) | (-3.435) | (-5.928) |
| **E/P** | | | | | 0.622*** | 0.473*** |
| | | | | | (16.941) | (10.277) |
| **BE/ME** | | | | | | 0.398*** |
| | | | | | | (8.467) |
| **Constant** | 1.909*** | 2.255*** | 1.906*** | 3.798*** | 2.348*** | 2.862*** |
| | (6.136) | (7.138) | (8.916) | (6.974) | (4.288) | (5.122) |
| **Bank fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Time fixed effects** | No | No | No | No | No | No |
| **$R^2$** | 0.001 | 0.003 | 0.003 | 0.013 | 0.032 | 0.041 |
| **N** | 20439 | 20439 | 20439 | 20439 | 20439 | 20439 |

| **Panel B** | | | | | | |
|---|---|---|---|---|---|---|
| **Equity/TA** | -0.095*** | -0.088*** | -0.110** | -0.152*** | -0.109** | -0.297*** |
| | (-3.483) | (-3.235) | (-2.290) | (-3.253) | (-2.415) | (-5.703) |
| **β** | | -0.163 | -0.761* | -0.696* | -0.785** | -0.651 |
| | | (-0.982) | (-1.834) | (-1.775) | (-1.987) | (-1.628) |
| **$β^2$** | | | 0.371 | 0.553** | 0.557** | 0.495* |
| | | | (1.251) | (1.978) | (2.056) | (1.655) |
| **Ln (TA)** | | | | -3.975*** | -3.504*** | -4.238*** |
| | | | | (-14.591) | (-12.050) | (-15.998) |
| **E/P** | | | | | 0.977*** | -0.142** |
| | | | | | (15.958) | (-2.119) |
| **BE/ME** | | | | | | -0.851*** |
| | | | | | | (-10.031) |
| **Constant** | -1.392*** | -0.014 | 0.435 | 5.889*** | 4.978*** | 6.602*** |
| | (-4.717) | (-0.047) | (0.978) | (14.486) | (11.620) | (16.784) |
| **Bank fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Time fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **$R^2$** | 0.062 | 0.032 | 0.031 | 0.065 | 0.069 | 0.074 |
| **N** | 20439 | 20439 | 20439 | 20439 | 20439 | 20439 |

Next we estimate a few regression models with non-parametric regressors. In particular, our previous results do not exclude any extreme values; nor did we apply any winsorizing on the data. We did not censor our data because it is well-known that the banking industry is dominated by a few very large banks whose size and market capitalization may be well out of the range of the remaining typical banks. Their exclusion would imply the overlooking of the most important players in the industry. However, extreme values may render the coefficients from the above regression models invalid if the slope of the fitted curve is severely swayed by a small fraction of outliers.

In order to alleviate such suspicions, we follow Chan el al (1996) and Cooper et al (2003) and rank all explanatory variables into percentiles and assign to each observations the number of their percentile ranking. For example, all observations that fall into the 95% size percentile would receive the value 0.95 as the non-parametric value for a new percentile-based regressor to substitute the original size variable. These regressors are then used in regressions of bank stock excess returns. As can be seen in Table VIII, most of our previous results survived in these non-parametric model formulations in terms of the sign and level of significance of the coefficients. Only beta has lost the level of significance observed before but the sign is still consistent[4]. Therefore, our previous findings are not likely to be the results of outliers or extreme observations.

### 2.6.2 Robustness check in sub-samples

Our main conclusions so far include: leverage has significantly positive implications on bank stock excess returns; beta has a convex non-linear relationship with returns; and size is inversely related to returns. These conclusions are mostly consistent across a variety of model specifications and conditioning set in terms of signs and level of significance. Questions may be raised regarding the persistency and stability of the coefficients over time. After all, our sample period of 1987-2007 cover a few important events. In the first decade of the sample period, there were S&L crisis in the early 1990s and the Asian financial crisis in 1997; during the second decade, Russian default, the fall of LTCM, and 9.11 terrorist attacks subsequently took place. It therefore is a relevant issue if the conclusion we arrived so far hold up in sub-samples of the covered time period. In Table IX, we report the results of the models run on the first and second decade of the sample period separately.

[4] The square of beta is omitted because its percentile ranking will highly correlate with the ranking of beta itself and thereby creates multicollinearity.

**Table VIII**
**Non-parametric regressions of bank stock excess returns**

All observations are ranked into percentiles based on each of the explanatory variables. Then a new set of variables are created that take as value the number of the percentile ranking of observations based one of the explanatory variables. This new set of percentile-based variables is then used in the regressions of bank stock excess returns. Model 1 is a Fama-MacBeth regression model; model 2 and 3 are panel data model with or without control for time fixed-effects, respectively. For model 1, $R^2$ is unavailable due to the Fama-MacBeth methodology; for model 2 and 3 $R^2$ is the overall model R-squared. *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level.

| | 1 | 2 | 3 |
|---|---|---|---|
| Equity/TA percentile | -0.089* | -0.064* | -0.065* |
| | (-1.70) | (-1.673) | (-1.650) |
| Beta percentile | -0.094 | -0.036 | -0.015 |
| | (-1.56) | (-0.915) | (-0.387) |
| Ln (TA) percentile | -0.242*** | -0.247*** | -0.250*** |
| | (-2.92) | (-5.963) | (-5.605) |
| E/P percentile | 0.458*** | 0.471*** | 0.498*** |
| | (7.41) | (11.620) | (10.467) |
| BE/ME percenile | 0.398*** | 0.385*** | 0.400*** |
| | (4.56) | (8.727) | (8.277) |
| Constant | -1.638*** | -1.632*** | -1.979*** |
| | (-2.44) | (-9.808) | (-8.610) |
| Bank fixed effects | No | Yes | Yes |
| Time fixed effects | No | No | Yes |
| $R^2$ | na | 0.049 | 0.055 |
| N | na | 20439 | 20439 |

Two main model specifications, a Fama-MacBeth style cross-sectional model and a panel data model controlling for both time and bank fixed-effects, are examined in these subsample periods. As can be seen in Table IX, the coefficients of the explanatory variables all have consistent signs across the subsample periods with what we have seen in the whole sample above implying that the conclusions we have reached so far also hold in the subsamples. However the level of significance can be different between the subsample periods. For example, in the cross-sectional specifications, the ratio of equity capital to total assets as a leverage measurement appears to be significantly different from zero only in the second decade of the sample period. In the panel data models however, this leverage measurement has a stronger level of significance in the first sub-period. The square of beta, though having consistent signs as previous results, lost its significance in most models in the subsamples. The relatively high standard errors in the smaller sample size could be the cause of this disappearance of significance. But our general conclusion still remains impact: leverage and beta seem to be relevant pricing factors for bank stock excess returns.

**Table IX**
**Robustness check in sub-samples**

The table reports the coefficients of the full regression models in two sub-periods. Fama-MacBeth regressions and panel data regressions are reported separately. The panel data models include both bank and year fixed effects. For the Fama-MacBeth regressions $R^2$ and sample size are not available. For the panel data regressions, $R^2$ is the overall model $R^2$. *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level.

| | Fama-MacBeth regressions | | Panel data regressions | |
|---|---|---|---|---|
| | 1987-1997 | 1998-2007 | 1987-1997 | 1998-2007 |
| Equity/TA | -3.452 | -8.031*** | -0.440** | -0.109* |
| | (-1.08) | (-2.65) | (-2.541) | (-1.876) |
| β | -0.208*** | -0.109** | -0.789 | -0.989* |
| | (-2.40) | (-2.18) | (-1.125) | (-1.953) |
| $\beta^2$ | 0.789 | 0.221 | 1.098 | 0.608* |
| | (1.45) | (1.326) | (1.493) | (1.889) |
| Ln (TA) | -0.227 | -0.268*** | -4.733*** | -3.134*** |
| | (-1.22) | (-7.479) | (-6.262) | (-10.284) |
| E/P | 0.527*** | 0.384*** | 1.139*** | 0.776*** |
| | (4.09) | (9.376) | (6.526) | (11.534) |
| BE/ME | 0.437*** | 0.386*** | 1.460*** | 0.620*** |
| | (2.15) | (8.794) | (5.594) | (7.125) |
| Constant | 2.170 | 3.562*** | 70.840*** | 40.637*** |
| | (0.75) | (6.362) | (6.253) | (9.162) |
| Bank fixed effects | - | - | Yes | Yes |
| Time fixed effects | - | - | Yes | Yes |
| $R^2$ | na | na | 0.101 | 0.083 |
| N | na | na | 5597 | 14842 |

### 2.7 Conclusion

This chapter takes the first step in filling in the gap in the existing asset pricing literature regarding the banking industry. The "mainstream" literature has mainly focused on the non-financial sectors because the typical value ranges of some variables are very different in the financial sector. The highly limited asset pricing literature that examines bank or financial stocks often assumes the validity of the non-financial literature and applies the pricing factors found to be important in the non-financial sectors directly in the financial stocks. As we have reviewed in this paper, the theories of financial intermediation and banking economics seem to suggest that some variables, shown to be negligible in the non-financial stocks, are likely to be relevant to the performance of bank stocks. Therefore, it becomes conceivable that some deviation from the existing literature may emerge if we specifically focus on the banking industry and independently extract and examine the asset pricing implications of what the banking literature has to offer.

Based on an extensive review of the banking literature, we examine the pricing effect of bank leverage and bank size on bank stock excess returns. While leverage has been shown to be inconsequential in the context of non-financial stocks, our results in the 1987-2007 period suggest a consistent and statistically strong positive relationship between leverage and bank stock returns. Banks that are highly leveraged, or have weaker capital strength have higher returns. This relationship is strong in both univariate models and in multivariate models that control for other bank characteristics and risk profile. This suggests that the investors of bank equity may have inadvertently exacerbated the buildup of high leverage in banks prior to the 2008/2009 financial crisis by giving the signal through bank stock returns that high leverage is more desirable. Bank size measured by total assets, on the other hand, has a significantly negative impact on bank stock returns. Large banks typically have lower excess returns than their smaller counterparts. This could be seen as the evidence for the diversification discount observed by Laeven and Levine (2007) where large and diversified financial conglomerates are worth less as a whole than the sum of their components if torn apart. Also interesting is that unlike in the non-financial world where market capitalization as a size proxy is an important pricing factor, bank stock returns do not seem to respond to total market capitalization. It is the total assets that have the significant relationship with bank stock returns.

The existing asset pricing literature for banks or financial firms typically neglects beta as a pricing factor because it has been shown in the non-financial firms that beta seems irrelevant. Our results in the banking sector demonstrate a strong and convex non-linear relationship between bank stocks returns and beta. Bank stock excess returns initially decreases with the increase of beta, but picks up again once beta becomes sufficiently small. This convex pattern is consistently strong in most model specifications. Therefore, unlike in the non-financial world where beta is shown to be negligible, the performance of bank stocks is likely to bear a close relationship with beta.

All in all, the punch line of this paper is that many established asset pricing factors in the non-financial industries may have limited applicability to stocks of the banking industry.

The meaningful decomposition or prediction of bank stock returns may benefit from the theories of financial intermediation and banking economics. We demonstrate in this paper that leverage, size and beta might be important pricing factors for U.S. bank stock excess returns at least for the 1987 to 2007 period.

# Chapter 3

## Banks, hedging, and derivatives [5]

### 3.1 Introduction

Banks' involvements in the derivatives markets have been considerably asymmetric with respect to trading and hedging activities. Compared with the value of derivatives used for trading, the value of derivatives held by banks for hedging is much lower. In addition, the pattern of growth in the value of hedging derivatives shows relatively lower growth rates but is more volatile than derivatives held for trading. Figure 1 below, adopted from OCC (2005), compares the level and pattern of growth of the notional amount of interest rate derivatives held by banks for hedging and trading purposes. The figure shows that the total notional amount of interest rate derivatives held by insured U.S. commercial banks approaches $100 trillion at the end of 2005, up from about $20 trillion at the beginning of 1997. However, only a small fraction of the 2005 amount ($2.6 trillion) is used for hedging purposes where the commercial banks hold the derivatives as end-users. In terms of growth, the change in value of derivatives used for hedging is nowhere near the derivatives used for trading. During our 1997-2005 sample period, the derivatives held for hedging purposes grew by 73 percent, in sharp contrast to the almost 400 percent of growth in the derivatives held for trading. At the cross-sectional level, banks appear not to consistently use derivatives for hedging. They increase, decrease, maintain, or eliminate altogether their derivatives positions for hedging in consecutive periods. This more volatile development in the banks' involvement in derivatives for hedging contrasts the more monotonically increasing pattern of growth seen in trading derivatives. The current literature so far has not offered a detailed account on the factors that drive bank's utilization of derivatives for hedging and the changes therein.

This chapter fills the aforementioned gap by empirically investigating two questions. First, what makes a bank hedge with derivatives in certain periods, but not in others? To answer this question, we construct a panel data set that comprises all U.S. bank holding companies (BHCs) that have used interest rate or credit derivatives during the period from 1997 to 2005. We use a combination of BHC balance sheet items and macroeconomic factors to answer the question whether or not a BHC hedges with either interest rate or credit derivatives. We find that banks are more likely to be hedgers with interest rate derivatives

[5] This chapter is based on Mahieu and Xu (2008).

when loan commitment, demand deposit, ROE, size and credit spread are higher; higher interest rate and term spread reduce the likelihood of a BHC being a hedger with interest rate derivatives. Higher transaction deposit, larger size and the engagement in the trading of credit derivatives induce banks to become hedgers with credit derivatives.

Second, we investigate how the changes in a bank's derivatives holdings can be explained. In order to preserve the maximum amount of information in the data, particularly in the BHCs that have only occasionally used derivatives for hedging and hence are sparsely populated in their derivatives related variables, we construct a discrete variable in our unbalanced panel dataset that corresponds to the directions and magnitudes of adjustments in the derivatives position on a quarterly basis. The first difference in the BHC balance sheet items and macroeconomic factors are then used to explain the ordered discrete outcomes in this panel data setting. The key findings include that the increases in Tier-I capital, size, interest rates and credit spreads lead to more hedging with interest rate derivatives. Increases in term spreads reduce such hedging activities. For credit derivatives we find that these instruments are more likely to be used for hedging when a bank engages in securitization and in the trading of credit derivatives. Our results therefore also fill in the gap in the literature that is mostly silent on the mechanisms underlying the changes in banks' existing derivative positions held for hedging.

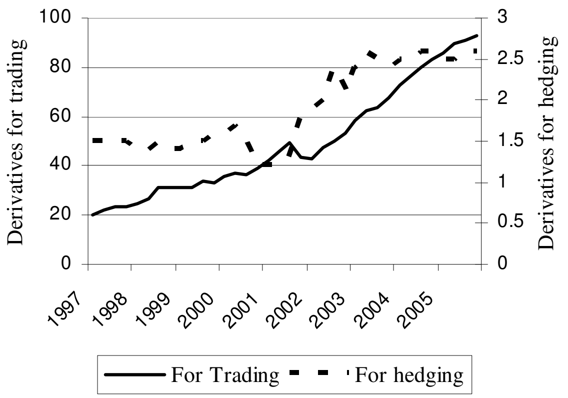


**Figure 1. The Volume and Growth of Interest Rate Derivatives.** The figure, adopted from the Bank Derivative Report (OCC 2005), shows the aggregate notional amount of interest rate derivatives held by U.S. insured commercial banks for trading and hedging purposes. The numbers on the Y-axis are in trillions and are quarterly observations.

Furthermore, the literature suggests that the use of derivatives for hedging is advantageous for banks in that derivative contracts enable banks to reduce their risks without having to deny, cancel, or renegotiate their loan arrangements with customers and thereby help banks to maintain their normal lending policy and customer relation (Allen and Santomoro 1998, Purnanandam 2007). Hedging with derivatives also allows banks to constantly adjust their risk exposures resulting from major banking services such as the commitment arrangements (Ho and Saunders 1983). Therefore, it is interesting to see the relationship between banks' hedging with derivatives and their financial intermediation function such as on- and off- balance sheet loan making activities.

The key findings that emerge from the analyses can be summarized as follows. First, the various categories of loan play little role in the use and modifications of both interest rate and credit derivatives. However, the increase in unused loan commitment contract significantly increases the likelihood that banks hedge with interest rate derivatives, which supports the suggestion by Ho and Saunders (1983) that banks can hedge the interest rate and take-down risks associated with loan commitment with financial derivatives since the fees paid by borrowers for these commitment cannot completely compensate such risks. The effect of loan commitment on the credit derivative is negative though insignificant, which lends weak support to Boot and Thakor (1991) and Avery and Berger (1991) in that loan commitment may reduce the credit exposure of banks and the need to hedge such risk.

Second, the increases in the size of banks measured by total asset result in higher probability that banks hedge with interest rate and credit derivatives. This is consistent with the suggestion that larger banks enjoy economies of scale, which result in a better cost-benefit tradeoff in the use of derivatives compared with smaller banks. Size also captures the accumulated systematic risk that grows with the scale or scope of banks but cannot be eliminated by their internal risk reduction methods such as underwriting standards, due diligence and diversifications (Allen and Santomero 1998). As to the micro-adjustments, larger increases in size make it more likely that a bank uses more interest rate derivatives to hedge but mildly reduces the hedging activity with credit derivatives.

Third, hedging with interest rate derivatives is significantly dampened by the increase in interest rate and term spread. This dampening effect of interest rate is consistent for banks with either negative or positive maturity gap. Since the rise in interest rate reduces the absolute market value of the maturity gap, this finding suggests that banks' hedging decision is not influenced by the sign of the maturity gap. Rather, as long as the assets and liabilities are mismatched, the movement in interest rate would result in active responses by banks in hedging with interest rate derivatives.

Fourth, the use of derivatives for hedging is likely to coexist with other risk reduction techniques. The use of loan sale is a complement to the increased use of interest rate derivatives, while securitization is likely to accompany credit derivatives.

Fifth, increases in the Tier-I risk capital significantly increase the likelihood that banks hedge and augment their hedging with interest rate derivatives. We argue that this is because Tier-I capital effectively captures shareholders' interest in a bank. Managers acting for the benefit of shareholders would hedge more to protect shareholder value when such value is larger.

Finally, banks that engage in the trading of credit derivatives tend to hedge more with credit derivatives since banks usually lay off the risks they take up in trading by entering into offsetting derivative contracts.

The outline of this chapter is as follows. We review the literature and formulate research questions in Section 3.2. After describing the data, the definition and construction of variables, and the empirical methodology in Section 3.3, we present the base model in Section 3.4 and its results in Section 3.5. Section 3.6 shows the model for the investigation of the model subtle changes in derivatives, followed by its results in Section 3.7. The last section concludes.

## 3.2 Bank characteristics, macroeconomic factors, and the use of derivatives for hedging

The bank specific characteristics we examine include size, various categories of loan, loan commitment, maturity gap, profitability, the liquidity of BHC balance sheet, Tier-1 risk capital, various measures of deposit, and other risk management techniques available to banks including loan sale and securitization. We also include in our conditioning set such macroeconomic factors as interest rates, the volatility of interest rates, term spread and credit spread. In this section we review the literature in the related topics and formulate research questions that we focus on in this paper. We occasionally discuss several characteristics together in view of their similarities.

### 3.2.1 Size

The size of a bank has been shown to positively affect their derivative usage (see Gorton and Rosen 1995, Carter and Sinkey 1998, Minton et al 2006, Purnanandam 2007). Such effect is attributed to the economy of scale enjoyed by large banks and their rich human as well as financial resources in establishing the internal operating and control system for derivative engagement (Carter and Sinkey 1998, Purnanandam 2007). Regulators also agree that the current concentration of derivative engagement at large banks is appropriate in view of the sophistication and talent needed for derivative transactions to be handled in a safe and sound manner (OCC 2005). Therefore, large banks are more likely to hedge with derivatives.

Does this also mean that as banks grow larger the likelihood of using derivatives for hedging increases? Or, will a bank increase its existing derivative holding for hedging purposes as it grows in size? It is conceivable that the hedging decision of banks is determined by other more subtle activities such as the types of loans made and/or macroeconomic movements. Therefore, it is interesting to see the relation between size and the likelihood of hedging with derivatives after controlling for other bank specific and macroeconomic factors. This incremental explanatory power of the size factor is conceivable considering the various types of risks faced by banks. Allen and Santomero (1998) classify three categories of risk faced by banks, namely, 1. risks associated with normal banking function such as loan making, 2. risks that are not to the advantage of banks to bear and to be transferred to others, and 3. risks that must be bore by banks themselves. All of these categories of risk imply a relationship between the size of a bank and the need for hedging with derivatives. More specifically, the cumulative systematic and idiosyncratic risks associated with loans may not be entirely captured by the amount of loan. While idiosyncratic risk could be eliminated by internal policies including, as Allen and Santomero (1998) specify, underwriting standards, due diligence procedures, and portfolio diversification, systematic risk must be hedged. As a consequence and considering the opaque nature of the risk structure of bank loans, the increase of loans does not necessarily increase the idiosyncratic risk which, in the extreme case where risk of loans is entirely idiosyncratic, may make conditioning on loans irrelevant to the risk profile of a bank and to the study on the need for hedging. However, as banks grow larger and make more loans, the cumulative systematic risk must then be captured by the size of the banks. As to the second category of risk in Allen and Santomero (1998) and also Diamond (1984), banks should hedge non-value adding risks, or the risks banks have no comparative advantage in bearing. Examples of these risks include interest rate risk and exchange risk that the general market understands well and banks have no relative advantage over other market participants in bearing them. These risks are similar with the systematic risk of loans and may be associated with other bank assets. Such risks, giving rise to the need for hedging, shall also be related, at least partially, to the size of the banks in addition to other bank balance sheet items depending on the unobservable idiosyncratic-systematic risk structure of the bank assets. The third category of risk in Allen and Santomero (1998) encompasses the intrinsic opaqueness and complexity of bank assets as well as potential agency problems between management and other stakeholders. All these risks further deepen the need for banks to hedge. While not directly measuring these risks and assuming these risks grow with the size of banks, we can expect a positive relationship between the size of a bank and the use of derivatives for hedging while controlling for other bank balance sheet items.

### 3.2.2 Bank loans

#### 3.2.2.1 On-balance sheet loans and macroeconomic risks

Bank loans as the assets of banks are risky investments made by the bank in various areas, ranging from commercial and industrial (C&I) loans, to loans to individual consumers. These loans also typically have longer maturity than the liabilities of banks. In other words, the assets of banks have longer maturity and therefore higher interest rate sensitivities than liabilities. In the mean time, depending on the borrowers, bank loans also bear various degrees of credit risk, the risk that the borrower defaults on the loan.

We choose to focus on interest rate and credit risk because among the various categories of risks the financial intermediaries encounter in their deposit taking and loan making activities, interest rate risk and credit risk are probably the most fundamental and pervasive to banks. More specifically, interest rate risk arises when there is maturity mismatches between banks' assets and liabilities, while the probability of borrowers defaulting, partially or fully, on loans gives rise to credit risk. Both categories of risk, though inherent in the financial intermediation process, adversely affect the operation of individual banks, particularly the loan making activities of banks. Interest rate uncertainty gives rise to refinancing risk when the maturity of assets is longer than liabilities, and to reinvestment risk when the maturity of assets is shorter than liabilities. Both may induce banks to shy away from illiquid asset and invest more in interest rate sensitive assets such as bonds and treasury bills. Credit risk may cause banks to reduce loan to relatively more risky business, and in the most extreme case, causes credit crunch. Noting that the loan making activities of banks to relatively illiquid and risky assets where asymmetric information is a more severe problem are the most valuable banking function, and noting that illiquid and risky loans bring more profit to banks, interest rate risk and credit risk, to the extent of being unpredictable or in excess of what banks are willing to take, interrupt the economic functioning and normal operation policy of banks.

One way to manage these risks is to increase or decrease the holding of assets that give rise to the interest rate or credit risk. Such operation would involve the acquisition of new assets, i.e., making new loans, or the premature sales of existing assets, e.g., loans to corporate clients, which entail high transaction costs, high value reduction due to the illiquidity of these assets, and the interruption of the lending policy as well as damage to the relationship with the corporate clients (Allen and Santomero 1998). As a risk management instrument, derivatives provide banks additional opportunity to manage their risk exposures. Hedging these risks with financial derivatives, which do not involve the counterparty of the loans, therefore becomes more sensible (Duffee and Zhou 2001, Purnanandam 2007).

The above review suggests that banks' decision on hedging with derivatives may be related to their loan making activities. Brewer, Minton and Moser (2000) find a positive relationship between banks' use of interest rate derivative for hedging and the making of C&I loans. Interest rate derivative also seem to insulate commercial banks from monetary policy shocks and help them maintain their lending volume (Purnanandam 2007). Purnanadam shows that the cumulative impact of monetary policy shocks on loan level is much smaller for derivative-user banks. Implicitly these studies assume that the use of derivatives for hedging is one of the reasons banks are able to issue more loans. Our approach differs from theirs in that we assume the loan making activities of banks result in the necessity to hedge. This assumption should be more reasonable since not until the loans are made can banks accurately determine their hedging need and actions on derivative positions. It is interesting to see if the increased use of derivatives is driven by the loan making activities of banks. The relevance of this issue is that one controversy concerning hedging with derivatives is the fear of systemic risk in which the counterparty of the derivatives became unable to honor the contract and this inability escalates to other related or unrelated parties. This is particularly relevant to banks since the failure of one large bank may have substantial consequences on the whole industry due to the concentration of derivative activities in large banks (Gorton and Rosen 1995). A recent article in *The Economist* expressed a similar concern among regulators and practitioners:

"The rise of the derivatives market has coincided with very low default rates. Were defaults to rise, the ability of the markets to absorb losses (and clear trades) might be severely tested." [6]

If systemic risk occurs, the liquidity creation of banks would also be hampered if banks rely too much on derivatives to neutralize the risks of their loans. In other words, if the derivative use for hedging by banks is driven by their loan growth, this could be taken as a sign that banks are transferring the risks intrinsic to their financial intermediation function to the derivative market and thereby signaling their inability to (completely) absorb the risks using their balance sheet. Then were the solvency of the derivative market to deteriorate, the availability of bank liquidity may also diminish.

3.2.2.2 Loan commitment

The loan commitment agreement is an important off-balance-sheet (OBS) loan making activity by banks. The quarterly Survey of Terms of Business Lending by the Federal Reserve[7] shows that around 80% of all C&I loans is made under commitment contracts during our 1997-2005 sample period. Due to the contingencies during the period between the establishment of the commitment contract and the actual takedown of the commitment, interest rate risk and credit risk may arise. Interest rates may vary dramatically and the creditworthiness of the counterparty may deteriorate, which will render the terms in the original contract more costly to serve.[8]

Financial derivatives may be a solution to the risks that arise *post* loan-commitment contracting. In particular, after the establishment of the commitment contract, banks could enter into an interest rate and/or credit derivative position upon the observation of new interest rate or credit condition as an effort to minimize the risks given rise by the interaction between the new movements and the terms specified in the loan commitment. Ho and Saunders (1983) suggest that hedging with interest derivatives the open loan commitment contract must be constantly adjusted as a response to the ever changing interest rate and the resulting change in

[6] See "What keeps bankers awake at night?" *The Economist*, February 3rd, 2007.

[7] http://www.federalreserve.gov/releases/e2/

[8] Even though the interest rate in the commitment contract can be specified as floating with spot loan rate, such as LIBOR, (in fact most loan commitment contracts are with floating rate (Shockley and Thakor 1997), the basis risk, the difference between the LIBOR and the cost of the fund banks use to honor the commitment, still can not be totally eliminated. As to the credit risk, the "adverse material change in conditions clause" in the loan commitment contract that entitles the bank to cancel or re-price the commitment contract can hardly be relied on in practice due to the possible legal claims resulted from the

loan price as well as the uncertain quantity of potential takedowns by the counterparty. Although we did not find any study that directly investigates the relation between derivative use and the loan commitment, literature does offer theories and evidence on the relation between loan commitment and banks' risk exposure. Clark and Siems (2002) show a positive association between loan commitment and the operating and interest expenses as well as the opportunity cost of bank equity capital (required rate of return multiplied by the market value of equity). They also show that derivative use reduces the above costs for U.S. commercial banks. Boot and Thakor (1991) and Avery and Berger (1991) however demonstrate a negative association between loan commitment and bank risk exposure. Their arguments include the rationing by banks that grants loan commitment contract to only creditworthy borrowers and the spontaneous risk control by banks on their own in view of the potential escalation of risk brought by the commitment contract. Note that these two studies focus on the credit risk exposure brought by the loan commitment while the study by Clark and Siems examine the interest rate risk. In light of these studies, interest rate and credit derivative can be used by banks to, for example, reduce the increased costs associated with honoring the commitment without having to renegotiate the terms therein. We contribute to the empirical literature by explicitly studying the relation between loan commitment and the need for hedging with interest rate and credit derivatives.

#### 3.2.2.3 Bank loans and bank liquidity

In the literature on underinvestment, hedging with derivatives has been shown to alleviate the potential underinvestment problem of only those firms that have weak cash position (Gay and Nam 1998, Deshmukh and Vogt 2005). Firms that have investment opportunities but strong cash position tend to have lower derivative engagement. This indicates the necessity of incorporating the strength of firms' cash or liquid asset in the study of the relation between their derivative use and investment activities. Applied to banks this means that the investment activities of banks, i.e., the loan making activities, and the resulting need for hedging may be contingent upon the amount of liquid asset in a bank, i.e., cash, federal funds and other liquid securities.

The liquidity of bank balance sheet may be an important determinant of derivative policy for two reasons. First, when external financing is sufficiently expensive, firms with

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damage to the counterparty (Saunders and Cornett 2006, page 367).

weak position in cash or other liquid asset are more prone to liquidity shocks and suffer from underinvestment problem (Froot et al 1993, Gay and Nam 1998, Deshmukh and Vogt 2005). To the extent that hedging with derivatives helps protect the liquidity position, there might be a relationship between the change in the liquidity measure of bank balance sheet and their subsequent decisions on derivatives. For example, in times of deteriorating credit condition, banks may suffer from loan loss and a reduction in their holding of liquid assets. Such event may be accompanied by a drop in derivative holdings as banks exercise or sell their derivative contract in an effort to make up for the drop in liquid assets. As such, there should be a positive association between derivative use and the liquidity measures of a bank. Second, Gatev and Strahan (2006) show that banks' holding of liquid assets will increase when the liquidity condition of the commercial paper market deteriorates and becomes unaffordable for corporations to obtain financing. That is, investors move their funds from the commercial paper market to banks when the credit conditions in the market become too risky. Gatev and Strahan conclude that such re-intermediation effect creates a natural hedging for banks on the balance sheet by increasing the liquid asset of banks when these assets are mostly needed as during market liquidity shocks that push firms to banks for refinancing their expiring commercial papers. In other words, the re-intermediation effect can be seen as a substitute for other hedging instruments such as derivative. The resulting relation between the growth of liquid asset and derivative usage should be negative. We try to clarify these contradictory issues in the existing literature by incorporating measures for liquid asset in our modeling.

### 3.2.3 Maturity gap and interest rates

In the case of interest rate risk, another complication is brought by the part of the loans that are not matched with corresponding source of financing and its relation with the interest rate risk. This is known as the maturity mismatch or maturity gap problem. Maturity gap is defined as the difference between a bank's nominal assets and nominal liabilities that are sensitive to interest rate movement. Generally speaking, what causes trouble is when the amount of interest rate sensitive assets is lower than the amount of interest rate sensitive liabilities. This asset shortage will render a bank economically insolvent when interest rate rises such that the market value of the liabilities rises above the market value of the assets and the value difference exceeds the value of equity capital in the meantime. This however does not mean that asset abundance is advantageous to banks. Flannery and James (1984) show that the stock market asks for higher returns the higher the maturity gap, positive or negative, which support their hypothesis that maturity gap partially determine the interest rate sensitivity of financial institutions stock returns. This means that in the valuation of financial institutions stocks investors consider the absolute value of the maturity gap rather than its sign. Hedging activity with derivatives has been shown to reduce the interest rate sensitivity of savings and loans associations' stocks returns after controlling for maturity gap (Schrand 1997). These findings collectively suggest that the study of the hedging activity by banks against interest rate risk with interest rate derivatives must also take into account the maturity gap of banks' balance sheet. The impact of interest rate risk on the need for hedging may be mediated by the magnitude and signs of maturity gap. We study this question by including maturity gap and then splitting the sample into two halves according to the signs of the mean maturity gap.

Purnanandam (2007) further suggests that maturity gap is also one method of hedging banks' interest rate risk, besides derivatives. He shows that derivative non-users tend to actively manage their maturity gap when faced with rising interest rate while derivative users appear nonchalant. Therefore, the inclusion of maturity gap in the conditioning set may also be motivated by the potential substitution effect on the use of interest rate derivatives.

### 3.2.4 Bank profitability

The literature generally shows a negative relation between profitability and the hedging behavior for non-financial firms (see e.g. Nance et al 1993,) and financial entities (see Purnanandam 2007 on interest rate derivative, and Minton et al 2006 on credit derivative). More profitable banks appear to have stronger financial strength against adverse shocks and are remote from financial distress, which reduce the likelihood for hedging. Yet the above two papers on financial institutions exclusively use profitability scaled by total asset of banks in their modeling. We expand the perspective by studying relation between other measures of profitability and the use of derivatives for hedging. The motivation is that the various measures of profitability have different emphasis and therefore divergent appealing to different groups of audience. Return to total asset (ROA) is useful in the study of the overall efficiency of a bank in using its asset. Return to equity (ROE) is particularly important to shareholders and is related to the charter value of a bank. The ratio of net interest income to total asset (interest margin), another popular measure of bank profitability, focuses on the interest-income generating ability of banks. Smith and Stulz (1985) and Stulz (1996) both suggest that the motivation for hedging may be different for different stakeholders. We therefore study these profitability measurements separately to improve the relevance to various interested audience.

### 3.2.5 Bank deposits

Gatev, Schuermann and Strahan (2005) and Kashyap, Rajan and Stein (2002) show that the inflow into transaction deposits, as long as not highly correlated with the demands from borrowers, creates a natural hedging against bank risk exposure, in much the same mechanism delineated in Gatev and Strahan (2006). Specifically, the flight to quality by investors during crisis transfers funds from the commercial paper market to bank deposits, which in turn enables banks to meet the increased liquidity demand from the loan commitment contracts during crisis and liquidity shortage in the commercial market. As such, the flow to deposits provides a natural hedging for banks to cover their liquidity needs, a potential substitution for derivatives. Minton, Stulz and Williamson (2006) also demonstrate a negative effect of total deposit ratio on the use of credit derivatives.

Considering the different degrees of liquidity associated with the various types of bank deposits however, there is a need to clarify the relation between deposits and hedging with derivatives more explicitly. In particular, in a descending order of withdrawal risk, demand deposits follow transaction deposits, which are then followed by savings and time deposits (Saunders and Cornett 2005). High levels of withdrawal risk reduce the liquidity of the deposit from the banks' perspective and in turn reduce the potential ability of deposits to substitute other hedging instruments such as derivatives. We study several measures of deposits to clarify this issue.

### 3.2.6 Tier I risk capital and other risk management instruments

The risk-adjusted capital requirement such as the Tier 1 capital in the Basel II framework is intended to serve as safety cushion against various contingencies. Banks with stronger capital position are arguably more capable of surviving interest rate or credit shocks. In this sense, the capital reserve of banks and other risk management policies such as derivatives may be substitute for each other. The theoretical works by Froot et al (1993) and Froot and Stein (1998) support such conjecture. They show that by engaging in risk management banks could be more capable of making risky loans whilst reducing capital holdings as a cushion against risks. This means controlling for the risk profile of bank loans, there ought to be a negative association between bank capital and the use of other risk management instruments such as derivatives. Empirical research has studied instruments such as loan sales and securitization as alternative means of managing risks. Cebenoyan and Strahan (2004) show that banks more actively involved in the loan-sale market hold less capital, thereby supporting the theory. Minton, Stulz and Williamson (2006) demonstrate a significantly negative association between Tier1 capital ratio and the likelihood of credit derivative use. Interestingly they also show that loan sales and securitization are significantly positively associated with the credit derivative use, which implies the coexistent and complementary relationship between these risk management instruments and derivatives but a substitution relation with the Tier-1 capital. We extend the literature by studying if the rise in Tier I capital contributes to the reduced use of derivatives. We also study if other risk management instruments, i.e., loan sales and securitization, are positively related to the increased use of derivatives for hedging.

### 3.2.7 Macroeconomic factors

The changes or modifications of banks' decision on hedging with derivatives are ultimately mandated by the dynamics of the macroeconomic environment that is constantly evolving. The interest rate and credit risk to some extent arise from the modification of monetary policy and the resulting movement in interest rate and credit conditions in the market, which in turn alter the asset-liability structure of banks and give rise to the duration mismatch and credit exposure. To control for the movements of the macroeconomic environment, we focus on interest rate, term spread, and credit spread. We use 3-month Treasury bill rate to measure interest rate. In our robustness test, we adopt the Federal Funds rate as the alternative measure of interest rate. While the T-Bill rate is commonly regarded as the risk-free cost of capital that is a benchmark to public borrowing, the fed funds rate captures the cost of capital of inter-bank borrowing most relevant to banks. The Fed funds rate is also the primary instrument for the Federal Reserve to guide monetary policy. Therefore, the Fed funds rate is a viable alternative to the T-Bill rate as a measure of interest rate. We also include the volatility of interest rate in our study. As will be explained later, we use the volatility cleansing procedure of Schwert (1989) to capture the unexpected part of the interest rate volatility.

The term spread between short term and long term interest rate captures the market expectation of the movement of the future interest rate. For example, an upward sloping term structure, or a positive term spread, means the market expects the short term interest rate to increase in future. Such an expectation and the change in this expectation may alter banks' need for hedging. For example, expecting a rising interest rate in the near future, a bank with more interest rate sensitive liabilities may enter into derivative position today to lock in a lower interest rate in an effort to offset the adverse impact of a higher rate on the value of the bank. The difference between the 1-year and 10-year U.S. T-Bill rate measures the term spread. In an effort to retain the part of the term spread that is not correlated with the short-term interest rate, we use the residual of the regression of term spread on a constant and the interest rate measure, the 3-month T-Bill rate, in the actual estimation.

Credit spread measures the additional premium the market requires for bearing the risk that the counterparty defaults. Credit spread is taken to be the spread between the 3-month commercial paper rate for highly rated (AA) nonfinancial borrowers and the 3-month T-bill rate (Gatev and Strahan 2006). However the credit spread of corporate bond also has interest rate component (see Duffee 1998 for the encompassing relation between T-bill yield and (non)callable bonds, Colline-Dufresne et al 2001 also shows such a relation though mild, Bakshi et al 2006 shows a much stronger relation for investment grade bonds). To refine the measurement and extract only the credit risk component, we use the residual of the regression of the credit spread on a constant and the 3-month T-bill rate.

## 3.3 Data

### 3.3.1 Sample, data, and variables

Using the database of bank holding companies (BHCs) maintained by the Federal Reserve Bank of Chicago, we construct a sample of all BHCs that hedged with interest rate or credit derivatives during the 1997 to 2005 period. These data are collected using the FR Y-9C report, which is the BHC equivalent of Call Report for the commercial banks (Minton, Stulz and Williamson 2006). Specifically, BHCs provide detailed information on their balance sheet items as well as off-balance-sheet (OBS) activities on a consolidated basis. The variables used in this study, their definition and construction are shown in Appendix. Two characteristics of the respondent panel are worth noticing. First, asset requirement in the FR Y-9C report narrows the sample to BHCs with total consolidated assets of $500 million or more (or BHCs meeting certain criteria regardless of size). Second, when such BHCs own or control, or are owned or controlled by, other BHCs, only the top-tier holding companies must file this report for the consolidated holding company organization. As a result of these reporting requirements, the starting point of our sample is the relatively large BHCs on a consolidated basis. We choose a sample starting point of 1997 only because it is the first year BHCs are required to report their engagement in credit derivatives. The data are available on a quarterly basis.

We match the quarterly observations on BHCs with macroeconomic factors in the corresponding quarter. Specifically, the two alternative measures of interest rate, the 3-month T-Bill rate and the overnight fed funds rate, are taken from the Federal Reserve Board of Governors statistical releases H.15. The 1-year and 10-year T-Bill rates are from the same source. The 3-month commercial paper rates for highly rated (AA) nonfinancial borrowers come from the commercial paper section of the statistical release by the Fed.

Note that we form an unbalanced sample with all available information. That is, a BHC needs to have at least two quarterly observations over the whole sample period to be included. This means we do not exclude BHCs that went bankrupt or merged or were acquired by other firms. The justification for this sample selection criterion is that BHCs arguably had financial distress or other value-depressing problems before disappearing from the whole sample. Though not explicitly modeled[9], financial distress is one of the factors that influence firms' hedging decisions (see e.g., Smith and Stulz 1985). Including them in unbalanced panel preserves valuable information as to the relation between a BHC's financial condition manifested on its balance sheet and its action on hedging with derivatives.

Also important to notice is that the reporting requirements call for the disclosure of the true derivative exposure of a BHC. Specifically, if a BHC bought protective derivative contract on its own behalf and also extended protection to others, these two sets of derivatives are required *not* to be netted. Contracts subject to bilateral netting arrangements are also required to be reported without netting.

### 3.3.2 Descriptive statistics

Table I provides the descriptive statistics of the variables. In this table we compare the level of derivatives held for hedging and other balance sheet items among four samples: the whole sample, the BHCs that use interest rate derivatives for hedging, the BHCs that hedge with

[9] See Purnanandam (2007) for the explicit modeling on financial distress and the use of interest rate

credit derivatives, and BHCs that hedge with both interest rate and credit derivatives. Note that since it is rarely the case that banks that hedge with credit derivative do not hedge with interest rate derivatives, the third and fourth groups are very similar. Also note that there are considerable variations in the use of interest rate and credit derivatives for hedging as measured by the standard deviations. In addition to studying such variations among BHCs this paper also investigate the within-BHC variations. The table also shows some other interesting comparisons: compared with the overall sample, banks that hedge with credit derivatives are much larger, have lower Tier-I capital ratio, lower interest income, more C&I loans, less deposits, much larger negative maturity gap and much higher unused commitment contract. All these differences seem to suggest BHCs that hedge with credit derivatives are more risky but apply less alternative methods or instrument for risk management.

Not shown in the table, the notional amount of interest rate derivatives held by all BHCs at the end of our sample period (2005Q4) equals 30% of the aggregate of their total assets. This percentage increases to 34% in the case of credit derivatives. At the beginning of our sample, the first quarter in 1997, these figures are 31% for interest rate derivatives and 0.2% for credit derivatives. The growth of these derivatives at the micro-level is also of interest. Over several consecutive periods in our sample, a BHC may increase or decrease their holding of interest rate or credit derivative. As to the macroeconomic variables, bear in mind that the term spread and credit spread are residuals of the regression of the original series on a constant and the 3-month T-Bill rate. They do not necessarily mean that the original mean term spread and credit spread are negative. The T-Bill rate volatility is calculated using the Schwert (1989) methodology[10].

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derivative for hedging.

[10] Specifically, we follow a three-step procedure in estimating the volatility of interest rate. (1) Estimate a $12^{th}$ order autorgression for the rates, including dummy variables to allow for different monthly mean returns, using all data available for the series. (2) Estimate a $12^{th}$ order autoregression for the absolute value of the errors from step 1, including dummy variables to allow for different monthly standard deviations. (3) The dependent variable in step 2 is an estimate of the standard deviation of the interest rate for t. The fitted value from step 2 estimates the conditional standard deviation of the interest rate given information available before t.

**Table I**
**Descriptive statistics**

This table presents the descriptive statistics for all variables involved. We report the mean, median and standard deviation (S.D.) of the variables. If not indicated, the unit of measurement is percentage. The descriptive statistics are reported for four groups: all available observations, those banks that hedge with interest rate derivatives, those banks that hedge with credit derivatives, and those banks that hedge with both interest rate and credit derivatives. Please refer to Appendix for the definition and construction of the variables.

| | All observations | | | Banks that hedge with interest rate derivatives | | | Banks that hedge with credit derivative | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Mean | Median | S.D. | Mean | Median | S.D. | Mean | Median | S.D. |
| Credit derivative notional (in thousands) | 412,739 | 0 | 13,221,720 | 2,492,139 | 0 | 32,411,608 | 32,027,813 | 1,196,000 | 112,000,000 |
| Interest rate derivative (in thousands) | 1,375,158 | 0 | 18,115,018 | 8,303,784 | 55,000 | 43,865,364 | 82,620,721 | 22,919,000 | 127,000,000 |
| Log (total asset) | 13.13 | 12.72 | 1.3 | 14.82 | 14.38 | 1.98 | 18.37 | 18.55 | 1.85 |
| Tier I capital ratio % | 9.03 | 8.5 | 3.43 | 8.21 | 7.8 | 3.32 | 6.7 | 6.63 | 3.15 |
| ROA % | 0.71 | 0.63 | 0.65 | 0.74 | 0.65 | 0.67 | 0.7 | 0.62 | 0.86 |
| ROE % | 7.79 | 7.21 | 15.09 | 8.6 | 7.95 | 7.14 | 8.23 | 8.31 | 8.76 |
| Interest margin % | 2.39 | 2.29 | 1.29 | 2.22 | 2.1 | 1.42 | 1.67 | 1.52 | 1.04 |
| Total loan ratio % | 64.56 | 66.03 | 13.19 | 63.85 | 65.94 | 14.46 | 52.84 | 58.07 | 18.11 |
| C&I loan ratio % | 10.89 | 9.55 | 7.13 | 12.11 | 10.95 | 8.1 | 13.29 | 12.91 | 6.9 |
| Other loan ratio % | 53.62 | 54.39 | 13.13 | 51.59 | 53.15 | 14.93 | 38.9 | 39.29 | 15.5 |
| Liquid asset ratio % | 29.6 | 28.32 | 12.98 | 28.37 | 26.98 | 12.74 | 28.47 | 26.95 | 10.89 |
| Total deposit ratio % | 80.01 | 82.4 | 10.11 | 71.17 | 73.9 | 14.63 | 52.25 | 60.11 | 20.28 |
| Demand deposit ratio % | 11.2 | 10.35 | 6.33 | 9.14 | 8.5 | 5.77 | 6.44 | 6.3 | 4.36 |
| Transaction account ratio % | 8.68 | 8.29 | 5.87 | 5.05 | 3.31 | 4.91 | 2.05 | 0.78 | 3.76 |
| Maturity gap ratio % | -6.45 | -6 | 19.46 | -13.43 | -13.04 | 18.69 | -22.51 | -23.83 | 15.79 |
| Nonperforming asset ratio % | 0.56 | 0.4 | 0.69 | 0.56 | 0.43 | 0.55 | 0.65 | 0.56 | 0.42 |
| Unused commitment ratio % | 9.28 | 6.19 | 28.85 | 19.69 | 9.17 | 67.21 | 38.47 | 33.35 | 31.34 |

*(Continued)*

**Table I Continued**

| Banks that hedge with both interest rate and credit derivative | | | |
|---|---|---|---|
| Variables | Mean | Median | S.D. |
| Credit derivative notional (in thousands) | 32,992,194 | 1,306,000 | 114,000,000 |
| Interest rate derivative (in thousands) | 85,113,587 | 24,625,003 | 129,000,000 |
| Log (total asset) | 18.53 | 18.63 | 1.61 |
| Tier I capital ratio % | 6.55 | 6.59 | 3.03 |
| ROA % | 0.7 | 0.62 | 0.87 |
| ROE % | 8.24 | 8.32 | 8.87 |
| Interest margin % | 1.65 | 1.51 | 1.03 |
| Total loan ratio % | 52.64 | 57.05 | 18.29 |
| C&I loan ratio % | 13.55 | 13.19 | 6.83 |
| Other loan ratio % | 38.43 | 38.95 | 15.4 |
| Liquid asset ratio % | 28.33 | 26.63 | 10.94 |
| Total deposit ratio % | 51.46 | 59.9 | 19.8 |
| Demand deposit ratio % | 6.29 | 6.21 | 4.25 |
| Transaction account ratio % | 1.65 | 0.76 | 2.88 |
| Maturity gap ratio % | -22.84 | -24.12 | 15.79 |
| Nonperforming asset ratio % | 0.66 | 0.57 | 0.42 |
| Unused commitment ratio % | 39.49 | 33.73 | 31.24 |

| Macroeconomic factors | | | |
|---|---|---|---|
| | Mean | Median | S.D. |
| 3-month T-Bill rate | 3.1 | 2.97 | 1.7 |
| Volatility of T-Bill rate | 0.13 | 0.11 | 0.09 |
| Term spread | -0.05 | -0.01 | 0.41 |
| Credit spread | -0.01 | 0 | 0.13 |

### 3.4 To use or not to use derivatives: the binary models

To answer the question why banks hedge with derivatives in certain periods but not in others, we implement the fixed effect logit model with binary outcomes in a panel data setting to study the relationship between the BHCs' status of being derivative user or nonuser for hedging and the BHC characteristics and macroeconomic factors discussed above. This methodology is based on Chamberlain (1980). Specifically, our dependent variable takes on two values:

$y_{it} = 1$ if BHC i uses derivatives in quarter t,

$y_{it} = 0$ if BHC i does not use derivatives in quarter t.

In a panel data setting, the underlying latent model takes the form $y^*_{it} = x'_{it}\beta + \alpha_i + \varepsilon_{it}$, where $\alpha_i$ is the BHC specific intercept and $\varepsilon_{it}$ is the unobserved disturbances. We observe $y_{it} =1$ if $y^*_{it} >0$ and $y_{it} =0$ otherwise. As in Chamberlain (1980) we specify $z_i = \Sigma_t y_{it}$, the sum of $y_i$ for the whole sample period, as the set of sufficient statistics for the conditional likelihood function. In other words, $z_i$, the number of quarters when a BHC used derivatives, is used to eliminate the BHC specific constant term $\alpha_i$ from the likelihood function. Therefore, our conditional likelihood functions, one for each BHC, contain the sufficient statistics $z_i$ and the parameters $\beta$, as well as $x_{it}$ and $\alpha_i$, in the conditioning set. The joint likelihood function of all BHCs over the sample period is then maximized with respect to the common $\beta$.

For example, suppose a BHC used derivative for hedging only once during its 36 quarters covered by the sample period. Then there are 36 alternative quarters when the use of derivative may occur. Suppressing the $\alpha_i$, $x_{it}$ and $\beta$ terms in the conditioning set and assuming a logit distribution, the conditional probability for this BHC must be one of the following:

$$\text{Prob}\,(1, 0, 0, \ldots, 0 \mid \Sigma_t y_{it} = 1) = \frac{e^{\beta'(x_{i1}-x_{i,36})}}{D}$$

$$\text{Prob}\,(0, 1, 0, \ldots, 0 \mid \Sigma_t y_{it} = 1) = \frac{e^{\beta'(x_{i,2}-x_{i,36})}}{D}$$

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$$\text{Prob}\ (0, 0, 0, \ldots, 1 \mid \Sigma_t y_{it} = 1) = \frac{1}{D},$$

$$\text{where D} = e^{\beta'(x_{i,1}-x_{i,36})} + e^{\beta'(x_{i,2}-x_{i,36})} + \cdots + e^{\beta'(x_{i,35}-x_{i,36})} + 1.$$

Analogously, the cases where $1 < \Sigma_t y_{it} < 36$ can be obtained by altering the terms in the nominators to include the corresponding combinations of $x_{it}$ terms. As can be seen from this example, the heterogeneity terms $\alpha_i$ no longer influence the outcomes of $y_{it}$. Also note that for those BHCs, whose $z_i = 0$ or T, meaning that they did not use derivative or used derivative during the entire sample period, the conditional distribution function is degenerate. These observations do not contribute to the conditional likelihood and therefore are excluded from the estimation. Intuitively, for these BHCs the probability of being derivative user or nonuser is known with certainty and therefore does not depend on the explanatory variables.

The Chamberlain (1980) approach allows us to draw inference regarding the interaction between BHCs decision on derivative and the firm specific and macroeconomic explanatory variables. Effectively, the likelihood that one BHC uses derivatives for hedging in some quarters is equated to a function of the explanatory variables corresponding to those derivative-using quarters and the nonderivative-using quarters. Therefore, we will know what difference in the BHC specific characteristics and/or macroeconomic factors results in the higher likelihood of being a derivative user.

We estimate the model coefficients for the use of interest rate derivative and credit derivative separately. We include all qualified observations by implementing the model in an unbalanced panel. Specifically, we do not put constraint on the number of quarters a BHC must be present in our sample. As long as there is a switching of status of being derivative user or not in the available quarters, a BHC is included in our estimation. In so doing, we retain the maximum amount of information the sample has to offer.

### 3.5 To use or not to use derivatives for hedging: results of the binary model

In order to facilitate a convenient overview on our results and comparison with the findings in the literature, we summarize the signs and levels of significance of variables in other studies and ours in Table II.

**Table II**

**Comparison of findings: hedging with interest rate and credit derivatives**

This table compares the major findings in the literature on the determinants of the use of interest rate derivatives (panel A) and credit derivative (panel B) for hedging with the findings in this paper. The estimation of the ordered multinomial fixed-effect panel logit model (the last column) uses the first difference in the explanatory variables. We present the signs and the significance levels of the variables modeled in the literature and in this paper. The sign "+" means the found relationship is positive. The sign "–" means the found relationship is negative. "*Mixed*" means that the signs may differ depending on the conditioning set. A blank cell means the corresponding variable is not covered in the study. Significance level: *** means significant at 1% level, ** at 5% level, and * at 10% level. If the significance levels are different in different conditioning sets, we report the lowest one. Please refer to Appendix for the description and construction of variables.

| Panel A: Determinants of interest rate derivatives | | | | |
|---|---|---|---|---|
| | Brewer, Minton and Moser (2000) | Purnanandam (2007) | This paper | |
| Methodology | Cross-sectional based on Chamberlain (1982, 1984) | Pooled logit | Binary fixed-effect panel logit based on Chamberlain (1980) | Ordered multinomial fixed-effect panel logit based on Ferrer-i-Carbonell and Frijters (2004) |
| Unused loan commitment | + | | + *** | - |
| Total loan ratio | | | + | + |
| C&I loan ratio | + ** | | - | - |
| Other loan ratio | | | + | + |
| Total deposit ratio | | - * | - *** | - |
| Demand deposit ratio | | | + *** | + |
| Transaction account ratio | | | - | + |
| Liquid asset ratio | | - *** | mixed | + |
| Tier 1 capital ratio | | | + | +*** |
| Equity ratio | + | | | |
| NPA ratio | | | mixed | - |
| C&I loan charge-off | - | | | |
| Maturity gap ratio | | + *** | - | - |
| ROA | | | + | - |
| ROE | | | + *** | - |
| Interest margin | | | + | - |
| Total asset growth | | + | | |
| Size | | + ** | + *** | + *** |
| Loan sale dummy | | | + *** | + *** |
| Securitization dummy | | | - | - |
| Trade interest rate derivative dummy | | | - *** | - |
| T-Bill rate | | - *** | - *** | + *** |
| Volatility of T-Bill rate | | - | - ** | - |
| Term spread | | - *** | - *** | - *** |
| Credit spread | | - *** | + *** | +*** |
| Employment growth | + | | | |
| Number of observations | 14181-18017 | 8439 | 13100 | 17400 |

**Table II Continued**

| Panel B: Determinants of credit derivatives | | | | |
|---|---|---|---|---|
| | Minton, Stulz and Williamson (2006) | | This paper | |
| Methodology | Panel and cross-section | Pooled logit | Binary fixed-effect panel logit based on Chamberlain (1980) | Ordered multivariate fixed-effect panel logit based on Ferrer-i-Carbonell and Frijters (2004) |
| Unused loan commitment | | - | - | + |
| Total loan ratio | | - *** | - | - |
| C&I loan ratio | + *** | mixed | - | - |
| Other loan ratio | mixed | - *** | mixed | + |
| Total deposit ratio | - | - *** | - | + |
| Demand deposit ratio | | - *** | - | + |
| Transaction account ratio | | + *** | + ** | + |
| Liquid asset ratio | + | mixed | - | - |
| Tier 1 capital ratio | - ** | + | + | - |
| Equity ratio | - | | | |
| NPA ratio | + | mixed | - | - |
| Maturity gap ratio | | - | + | - |
| ROA | | + | - | + |
| ROE | | - | - | - |
| Interest margin | - *** | - *** | - * | - |
| Size | + *** | + *** | + *** | - |
| Loan sale dummy | + *** | + | mixed | - |
| Securitization dummy | + *** | + *** | + | + ** |
| Trade credit (this paper) or other derivatives (Minton et al 2006) dummy | + *** | + *** | + *** | + *** |
| T-Bill rate | | - *** | - | + |
| Volatility of T-Bill rate | | + | + | - |
| Term spread | | - *** | - | - |
| Credit spread | | mixed | - | + |
| Sample period | 1999-2003 | | 1997-2005 | |
| Number of observations | 294 - 529 | 54400 | 1071 | 1612 |

### 3.5.1 Hedging with interest rate derivatives

We summarize and analyze the results from fixed effects logit model with binary outcomes. As aforementioned, these results answer the question why a bank hedge in some quarters with derivatives but not in others.

As can be seen in the fourth column in Table II Panel A and also in Table III the relationship between various categories of on-balance sheet loans and the likelihood of hedging with interest rate derivative is consistently weak. None of the loan to total asset ratios is statistically significant. However, the ratio of unused loan commitment to total asset is statistically significant and positive.

Together the coefficients of these loan-related variables suggest that it is not the on-balance sheet loans but the off-balance sheet loan commitment arrangements that determine if a bank uses interest rate derivative to hedge in some quarters but not in others. This is consistent with the theoretical suggestion by Ho and Saunders (1983). It seems that banks need additional protection against the risks brought by the increased level of loan commitment, which may not be completely compensated by the fees charged on these off-balance sheet instruments. Our findings suggest that banks tend to transfer their off-balance sheet rather than on-balance sheet loan risk to other parties via interest rate derivative. Given the fact that about 80 percent of C&I loans are made through loan commitment, the insolvency in the interest rate derivative market may well result in credit crunches in the C&I loan market as banks may fail to fulfill previously established commitment contracts or request the renegotiation of the terms in the contracts. In the mean time, the existing loans should not be adversely affected. What deserves attentions for the borrowing companies is the refinancing of these loans or commercial papers through the established commitment arrangements.

As shown in the Table III, the various measure of deposit enters the model separately. The effect of total deposit appears to be significantly negative, which support the natural hedging mechanism in Gatev and Strahan (2006); the coefficients of demand deposit are comparably significant but positive. The transaction account does not seem to have a meaningful influence. Deposits that are insured by the Federal Deposit Insurance Corporation may offer a natural hedging for the cash flows of banks (Gatev, Schuermann and Strahan 2005, Gatev and Strahan 2006). The flight-to-quality motivation of the investors during bad times, which results in the credit market for firms to shrink due to high risk, also produces cash inflows for banks as investors move their funds to bank deposits, thereby naturally hedging the shortfall of funds in funds as firms now turn to banks for financing. Since total deposit can be decomposed into demand deposit, transaction account and various categories of time deposit, and savings and money market accounts, our results imply that the substitution effect between deposit and derivative mainly comes from deposits other than demand deposit. Considering the characteristics of demand deposit, such results are not surprising. Demand deposit is subject to high withdrawal risk and the cost of non-interest bearing reserve requirements. This means that demand deposit is an unreliable and expensive source of financing for banks. The same also holds for the transaction accounts, though to a lesser extent due to the interest paying ability and minimum balance requirement normally imposed on depositors by banks. Money market account, savings account and time deposit all have less withdrawal risk than demand deposit and transaction account and therefore should be a more reliable source of financing.

The spread between the risk-free interest rate and the AA non-financial commercial paper rate, our measure of the credit spread, significantly increases the likelihood of a BHC hedging with interest rate derivatives. The commercial paper market is a substitute source of financing for companies besides bank loans. In usual times, companies increasingly find the commercial paper market offering more favorable rates for their financing needs. However, as the condition in commercial paper market tightens and the spread of commercial paper above treasury bills shoots up, companies would find refinancing their expiring commercial papers impossible and resort to banks, in particular their unused bank loan commitment contract for the rescue (Gatev and Strahan 2006). This is also one of the risks accompanied with loan commitment envisioned by Ho and Saunders (1983). Banks in this situation may face sudden takedowns on their loan commitments and the associated liquidity shortage. With this knowledge, it should come with no surprise that the increase in the credit spread makes it more likely for banks to hold derivative protections.

The management of the maturity gap ratio, as an on-balance sheet hedging alternative to the off-balance sheet hedging with interest rate derivative (Purnanandam 2007), has a consistently negative, albeit insignificant, impact on the likelihood of hedging with interest rate derivatives. Given the negative mean gap ratio in our sample, the reduction in the asset shortfall provides weak substitute for the interest rate derivative as a hedging instrument. Such a weak relation may be because the adjustments to assets, i.e., the reduction of existing loans or acquisition of new ones, are not as easy as entering into a derivative contract.

The level and volatility of interest rate and the term spread between short and long term interest rate all have significantly negative impact on the likelihood of hedging with interest rate derivative. We suggest that the interest rate variables must be considered together with the negativity of the gap ratio in our sample that is also in the conditioning set. Given a mean asset shortfall in our sample, an increase in the interest rate will reduce the market value of this shortfall and push the maturity gap closer to zero, which in turn reduces the need for hedging. Such an interpretation raises another question: will the effect of interest rate movement be different should the sample mean gap be positive?

**Table III**

**To Use or not to Use Interest Rate Derivatives: Conditional Logit Panel Data Model with Binary Outcome**

This table reports the estimation output of the conditional logit model with the binary outcome of hedging with *interest rate derivative* as the dependent variable. The Models are estimated using methodology based on Chamberlain (1980). Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1 ratio | 0.0154 | 0.0158 | 0.0141 | 0.0330** | 0.0320* | 0.0325** | 0.0316* | 0.0382** | 0.0369** |
| | (0.0177) | (0.0176) | (0.0179) | (0.0165) | (0.0168) | (0.0163) | (0.0166) | (0.0165) | (0.0169) |
| Loan sale | 0.6740*** | 0.6698*** | 0.6661*** | 0.7014*** | 0.6995*** | 0.7037*** | 0.7012*** | 0.7068*** | 0.7045*** |
| | (0.1180) | (0.1181) | (0.1180) | (0.1161) | (0.1160) | (0.1161) | (0.1161) | (0.1161) | (0.1160) |
| Securitization | -0.0681 | -0.0657 | -0.0608 | -0.0331 | -0.0284 | -0.0302 | -0.0255 | -0.0511 | -0.0461 |
| | (0.4775) | (0.4776) | (0.4785) | (0.4766) | (0.4771) | (0.4778) | (0.4783) | (0.4767) | (0.4772) |
| Size | 3.4595*** | 3.4517*** | 3.4577*** | 3.6126*** | 3.6178*** | 3.5179*** | 3.5218*** | 3.6483*** | 3.6535*** |
| | (0.1672) | (0.1672) | (0.1670) | (0.1604) | (0.1602) | (0.1584) | (0.1581) | (0.1606) | (0.1604) |
| ROA | 0.0048 | 0.0038 | 0.0032 | | | | | | |
| | (0.0416) | (0.0417) | (0.0416) | | | | | | |
| ROE | | | | 0.0185*** | 0.0183*** | 0.0184*** | 0.0182*** | | |
| | | | | (0.0051) | (0.0051) | (0.0051) | (0.0051) | | |
| Interest margin | | | | | | | | 0.0377 | 0.0365 |
| | | | | | | | | (0.0248) | (0.0248) |
| Total loan ratio | 0.0029 | | | | | | | | |
| | (0.0115) | | | | | | | | |
| C&I loan ratio | | -0.0113 | | -0.0077 | | -0.0050 | | -0.0085 | |
| | | (0.0112) | | (0.0110) | | (0.0109) | | (0.0110) | |
| Other loan ratio | | | 0.0131 | | 0.0084 | | 0.0075 | | 0.0094 |
| | | | (0.0088) | | (0.0086) | | (0.0086) | | (0.0086) |
| Liquid asset ratio | -0.0019 | -0.0057 | 0.0054 | -0.0063 | 0.0009 | -0.0048 | 0.0014 | -0.0059 | 0.0022 |
| | (0.0113) | (0.0057) | (0.0086) | (0.0056) | (0.0084) | (0.0056) | (0.0084) | (0.0056) | (0.0084) |

(*Continued*)

**Table III: continued**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Total deposit ratio | -0.0278*** | -0.0271*** | -0.0276*** | | | | | | |
| | (0.0076) | (0.0076) | (0.0076) | | | | | | |
| Demand deposit ratio | | | | 0.0260*** | 0.0257*** | | | 0.0245** | 0.0243** |
| | | | | (0.0096) | (0.0096) | | | (0.0096) | (0.0095) |
| Transaction account ratio | | | | | | -0.0026 | -0.0027 | | |
| | | | | | | (0.0094) | (0.0094) | | |
| Gap ratio | -0.0035 | -0.0034 | -0.0036 | -0.0023 | -0.0023 | -0.0030 | -0.0030 | -0.0027 | -0.0028 |
| | (0.0026) | (0.0025) | (0.0025) | (0.0025) | (0.0025) | (0.0025) | (0.0025) | (0.0025) | (0.0025) |
| Non-perform asset ratio | -0.0676 | -0.0645 | -0.0621 | 0.0044 | 0.0055 | -0.0046 | -0.0030 | -0.0339 | -0.0323 |
| | (0.0703) | (0.0705) | (0.0705) | (0.0712) | (0.0712) | (0.0712) | (0.0713) | (0.0695) | (0.0695) |
| Unused commitment | 0.0264*** | 0.0271*** | 0.0266*** | 0.0264*** | 0.0261*** | 0.0267*** | 0.0265*** | 0.0271*** | 0.0267*** |
| | (0.0053) | (0.0053) | (0.0052) | (0.0051) | (0.0050) | (0.0051) | (0.0050) | (0.0050) | (0.0050) |
| Trade IR derivative | -1.3526*** | -1.3460*** | -1.3408*** | -1.3265*** | -1.3228*** | -1.3407*** | -1.3360*** | -1.3113*** | -1.3073*** |
| | (0.2383) | (0.2384) | (0.2380) | (0.2336) | (0.2334) | (0.2346) | (0.2344) | (0.2341) | (0.2338) |
| T-Bill rate | -0.1431*** | -0.1403*** | -0.1459*** | -0.1441*** | -0.1478*** | -0.1453*** | -0.1484*** | -0.1428*** | -0.1469*** |
| | (0.0226) | (0.0220) | (0.0221) | (0.0218) | (0.0219) | (0.0218) | (0.0219) | (0.0218) | (0.0219) |
| Volatility of T-Bill rate | -0.8559** | -0.8346** | -0.8711** | -0.9811*** | -1.0032*** | -0.9841*** | -1.0013*** | -0.9331*** | -0.9556*** |
| | (0.3453) | (0.3440) | (0.3441) | (0.3406) | (0.3405) | (0.3405) | (0.3404) | (0.3472) | (0.3470) |
| Term spread | -1.4492*** | -1.4391*** | -1.4485*** | -1.4184*** | -1.4243*** | -1.4185*** | -1.4226*** | -1.4037*** | -1.4104*** |
| | (0.0824) | (0.0822) | (0.0819) | (0.0806) | (0.0803) | (0.0807) | (0.0804) | (0.0805) | (0.0802) |
| Credit spread | 0.7977*** | 0.8014*** | 0.7930*** | 0.7468*** | 0.7431*** | 0.7663*** | 0.7629*** | 0.7877*** | 0.7844*** |
| | (0.2327) | (0.2326) | (0.2327) | (0.2309) | (0.2309) | (0.2308) | (0.2308) | (0.2329) | (0.2329) |
| Obs | 13100 | 13100 | 13100 | 13400 | 13400 | 13400 | 13400 | 13400 | 13400 |
| Pseudo $R^2$ | 0.2629 | 0.2630 | 0.2631 | 0.2627 | 0.2627 | 0.2621 | 0.2621 | 0.2616 | 0.2617 |

Table IV and V answer the above question. We split the sample into two parts, one with the BHCs that have positive mean gap ratio and another with negative mean gap ratio over the sample period, and apply the same econometric modeling. Clearly the effect of the level of interest rate movement has the same effect on the likelihood of using interest rate derivatives in both sub-samples. The coefficients are consistently and significantly negative. Apparently, what matters to the risk management of banks is the magnitude of the gap rather than the sign. The increases in interest rate will also reduce the positive gap to a smaller figure closer to zero. As maturity gap approaches zero, the need for a bank to hedge reduces. This explains why we have the same result as Purnanandam (2007) who uses the absolute value of the maturity gap measure. Similarly, Schrand (1997) finds that hedging with interest rate derivative always move maturity gaps, positive or negative, closer to zero and thereby reduces banks stock interest rate sensitivity. Purnanandam deduces that the negative impact of interest rate on the likelihood of derivative use may result from banks closing their previous derivative contracts in a rising interest rate environment to meet loan demands.

However, our analysis in the two sub-samples reveals a difference in the effect of the volatility of interest rate on the likelihood of derivative use. While the impact of the monthly standard deviation of the interest rate consistently has negative signs, such negative impact is statistically significant for those BHCs that have a negative mean gap ratio as shown in Table V. How could this phenomenon be explained? As the volatility of the interest rate increases, the value of the gap also becomes more volatile, which can be translated into higher interest rate risk. It is possible that the conjecture by Purnanandam (2007) also applies here. Banks may exercise their derivative holdings in times of rising interest rate risk and realize the compensation from these derivative contracts for their liquidity shortfall. Such a tendency should be stronger for banks with a negative gap ratio. Another possible explanation is that the price for the derivative contract, e.g., the up-front fees for options, may become unaffordable in times of high risk. The banks with a negative gap ratio are more likely to exercise the derivative contracts and therefore may face even higher obstacles in entering such a protective arrangement.

The spread between the one-year and 10-year Treasury bill rate appears to significantly reduce the likelihood of banks using interest rate derivatives for hedging. This significance should also be considered together with the conditioning on the gap ratio.

**Table IV**

**Banks with Positive Maturity Gap and the Use of Interest Rate Derivatives for Hedging**

The models reported in this table are estimated using the same methodology and conditioning set as in Table III but in the sub-sample of bank with *positive* maturity gag. Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1 ratio | -0.0206 | -0.0153 | -0.0154 | 0.0595* | 0.0590* | 0.0598* | 0.0592* | 0.0601* | 0.0598* |
| | (0.0374) | (0.0371) | (0.0373) | (0.0330) | (0.0332) | (0.0331) | (0.0332) | (0.0331) | (0.0332) |
| Loan sale | 0.4790** | 0.4776** | 0.4776** | 0.5192*** | 0.5185*** | 0.5288*** | 0.5280*** | 0.5206*** | 0.5198*** |
| | (0.1996) | (0.2000) | (0.1998) | (0.1971) | (0.1969) | (0.1974) | (0.1972) | (0.1970) | (0.1969) |
| Securitization | 1.0879 | 1.1102* | 1.1084 | 1.1247* | 1.1210* | 1.1332* | 1.1279* | 1.1201* | 1.1176* |
| | (0.6723) | (0.6743) | (0.6747) | (0.6506) | (0.6507) | (0.6520) | (0.6519) | (0.6534) | (0.6535) |
| Size | 2.1035*** | 2.1448*** | 2.1517*** | 2.7386*** | 2.7382*** | 2.7479*** | 2.7477*** | 2.7608*** | 2.7619*** |
| | (0.3083) | (0.3047) | (0.3074) | (0.3011) | (0.3042) | (0.2975) | (0.2997) | (0.3015) | (0.3045) |
| ROA | 0.0196 | 0.0208 | 0.0156 | | | | | | |
| | (0.1246) | (0.1244) | (0.1242) | | | | | | |
| ROE | | | | 0.0183* | 0.0182* | 0.0200* | 0.0199* | | |
| | | | | (0.0110) | (0.0110) | (0.0110) | (0.0110) | | |
| Interest margin | | | | | | | | 0.0241 | 0.0241 |
| | | | | | | | | (0.0472) | (0.0473) |
| Total loan ratio | -0.0153 | | | | | | | | |
| | (0.0308) | | | | | | | | |
| C&I loan ratio | | -0.0252 | | -0.0105 | | -0.0090 | | -0.0096 | |
| | | (0.0241) | | (0.0229) | | (0.0228) | | (0.0229) | |
| Other loan ratio | | | 0.0108 | | 0.0007 | | -0.0004 | | 0.0014 |
| | | | (0.0193) | | (0.0185) | | (0.0183) | | (0.0185) |
| Liquid asset ratio | -0.0256 | -0.0132 | -0.0019 | -0.0140 | -0.0126 | -0.0154 | -0.0151 | -0.0133 | -0.0114 |
| | (0.0307) | (0.0106) | (0.0196) | (0.0103) | (0.0189) | (0.0103) | (0.0188) | (0.0103) | (0.0189) |

(*Continued*)

**Table IV continued**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Total deposit ratio | -0.0841*** | -0.0836*** | -0.0844*** | | | | | | |
| | (0.0160) | (0.0160) | (0.0159) | | | | | | |
| Demand deposit ratio | | | | 0.0301 | 0.0290 | | | 0.0304 | 0.0296 |
| | | | | (0.0267) | (0.0268) | | | (0.0267) | (0.0268) |
| Transaction account ratio | | | | | | 0.0323* | 0.0322* | | |
| | | | | | | (0.0188) | (0.0188) | | |
| Gap ratio | -0.0028 | -0.0028 | -0.0028 | -0.0034 | -0.0035 | -0.0035 | -0.0035 | -0.0037 | -0.0037 |
| | (0.0042) | (0.0042) | (0.0042) | (0.0041) | (0.0041) | (0.0041) | (0.0041) | (0.0041) | (0.0041) |
| Non-perform asset ratio | -0.7296*** | -0.7235*** | -0.7293*** | -0.6684*** | -0.6713*** | -0.6498*** | -0.6526*** | -0.6828*** | -0.6853*** |
| | (0.1747) | (0.1749) | (0.1748) | (0.1709) | (0.1708) | (0.1707) | (0.1706) | (0.1706) | (0.1705) |
| Unused commitment | 0.0803*** | 0.0836*** | 0.0810*** | 0.0626*** | 0.0613*** | 0.0629*** | 0.0616*** | 0.0620*** | 0.0609*** |
| | (0.0249) | (0.0251) | (0.0249) | (0.0238) | (0.0237) | (0.0238) | (0.0236) | (0.0237) | (0.0236) |
| Trade IR derivative | -1.2387*** | -1.2408*** | -1.2469*** | -1.1319*** | -1.1341*** | -1.1229*** | -1.1249*** | -1.0799** | -1.0822** |
| | (0.4374) | (0.4379) | (0.4379) | (0.4252) | (0.4247) | (0.4226) | (0.4222) | (0.4234) | (0.4230) |
| T-Bill rate | -0.1976*** | -0.2039*** | -0.2087*** | -0.2057*** | -0.2061*** | -0.2072*** | -0.2071*** | -0.2078*** | -0.2084*** |
| | (0.0424) | (0.0404) | (0.0411) | (0.0397) | (0.0404) | (0.0398) | (0.0405) | (0.0397) | (0.0404) |
| Volatility of T-Bill rate | -0.3511 | -0.3563 | -0.3868 | -0.6220 | -0.6393 | -0.6436 | -0.6584 | -0.5326 | -0.5498 |
| | (0.6348) | (0.6331) | (0.6329) | (0.6187) | (0.6176) | (0.6193) | (0.6182) | (0.6285) | (0.6271) |
| Term spread | -1.3652*** | -1.3565*** | -1.3713*** | -1.2777*** | -1.2842*** | -1.3006*** | -1.3059*** | -1.2693*** | -1.2751*** |
| | (0.1516) | (0.1516) | (0.1508) | (0.1485) | (0.1478) | (0.1480) | (0.1474) | (0.1484) | (0.1477) |
| Credit spread | 0.5027 | 0.4923 | 0.4952 | 0.5356 | 0.5396 | 0.5382 | 0.5419 | 0.6092 | 0.6114 |
| | (0.4265) | (0.4268) | (0.4266) | (0.4210) | (0.4209) | (0.4213) | (0.4212) | (0.4229) | (0.4228) |
| Obs | 3944 | 3944 | 3944 | 4054 | 4054 | 4055 | 4055 | 4054 | 4054 |
| Pseudo $R^2$ | 0.2626 | 0.2633 | 0.2630 | 0.2629 | 0.2629 | 0.2619 | 0.2625 | 0.2618 | 0.2620 |

**Table V**
**Banks with Negative Maturity Gap and the Use of Interest Rate Derivatives for Hedging**

The models reported in this table are estimated using the same methodology and conditioning set as in Table III but in the sub-sample of bank with *negative* maturity gag. Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1 ratio | 0.0175 | 0.0195 | 0.0146 | 0.0218 | 0.0182 | 0.0210 | 0.0177 | 0.0288 | 0.0248 |
| | (0.0225) | (0.0219) | (0.0227) | (0.0208) | (0.0215) | (0.0205) | (0.0211) | (0.0206) | (0.0213) |
| Loan sale | 0.8245*** | 0.8210*** | 0.8109*** | 0.8554*** | 0.8488*** | 0.8591*** | 0.8509*** | 0.8636*** | 0.8568*** |
| | (0.1480) | (0.1485) | (0.1483) | (0.1455) | (0.1455) | (0.1457) | (0.1456) | (0.1455) | (0.1454) |
| Securitization | -1.7013** | -1.7070** | -1.7088** | -1.8136*** | -1.8125*** | -1.8339*** | -1.8320*** | -1.8495*** | -1.8495*** |
| | (0.6885) | (0.6874) | (0.6917) | (0.6976) | (0.7010) | (0.6946) | (0.6972) | (0.6959) | (0.6999) |
| Size | 4.0205*** | 4.0118*** | 4.0106*** | 4.0381*** | 4.0374*** | 3.9004*** | 3.8968*** | 4.0790*** | 4.0777*** |
| | (0.2021) | (0.2023) | (0.2020) | (0.1930) | (0.1927) | (0.1901) | (0.1896) | (0.1932) | (0.1929) |
| ROA | 0.0121 | 0.0109 | 0.0111 | | | | | | |
| | (0.0444) | (0.0443) | (0.0443) | | | | | | |
| ROE | | | | 0.0199*** | 0.0197*** | 0.0196*** | 0.0194*** | | |
| | | | | (0.0058) | (0.0058) | (0.0058) | (0.0058) | | |
| Interest margin | | | | | | | | 0.0409 | 0.0393 |
| | | | | | | | | (0.0294) | (0.0294) |
| Total loan ratio | 0.0068 | | | | | | | | |
| | (0.0128) | | | | | | | | |
| C&I loan ratio | | -0.0074 | | -0.0063 | | -0.0026 | | -0.0076 | |
| | | (0.0129) | | (0.0126) | | (0.0126) | | (0.0126) | |
| Other loan ratio | | | 0.0150 | | 0.0114 | | 0.0105 | | 0.0125 |
| | | | (0.0104) | | (0.0101) | | (0.0101) | | (0.0101) |
| Liquid asset ratio | 0.0057 | -0.0010 | 0.0106 | -0.0021 | 0.0068 | 0.0010 | 0.0087 | -0.0018 | 0.0080 |
| | (0.0126) | (0.0068) | (0.0098) | (0.0068) | (0.0096) | (0.0068) | (0.0096) | (0.0068) | (0.0096) |

(*Continued*)

## Table V continued

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Total deposit ratio | -0.0112 | -0.0105 | -0.0105 | | | | | | |
| | (0.0088) | (0.0088) | (0.0088) | | | | | | |
| Demand deposit ratio | | | | 0.0281*** | 0.0279*** | | | 0.0263** | 0.0261** |
| | | | | (0.0105) | (0.0104) | | | (0.0104) | (0.0104) |
| Transaction account ratio | | | | | | -0.0169 | -0.0168 | | |
| | | | | | | (0.0111) | (0.0111) | | |
| Gap ratio | -0.0028 | -0.0027 | -0.0029 | -0.0011 | -0.0013 | -0.0023 | -0.0025 | -0.0019 | -0.0020 |
| | (0.0032) | (0.0032) | (0.0032) | (0.0032) | (0.0032) | (0.0032) | (0.0032) | (0.0032) | (0.0032) |
| Non-perform asset ratio | 0.0915 | 0.0933 | 0.0990 | 0.1665** | 0.1700** | 0.1496* | 0.1541* | 0.1135 | 0.1177 |
| | (0.0782) | (0.0784) | (0.0785) | (0.0800) | (0.0800) | (0.0801) | (0.0802) | (0.0771) | (0.0771) |
| Unused commitment | 0.0270*** | 0.0276*** | 0.0272*** | 0.0263*** | 0.0260*** | 0.0266*** | 0.0265*** | 0.0270*** | 0.0266*** |
| | (0.0054) | (0.0054) | (0.0054) | (0.0053) | (0.0052) | (0.0052) | (0.0052) | (0.0052) | (0.0052) |
| Trade IR derivative | -1.4279*** | -1.4252*** | -1.4118*** | -1.4331*** | -1.4236*** | -1.4501*** | -1.4385*** | -1.4318*** | -1.4220*** |
| | (0.2858) | (0.2861) | (0.2855) | (0.2804) | (0.2799) | (0.2820) | (0.2816) | (0.2813) | (0.2808) |
| T-Bill rate | -0.1204*** | -0.1158*** | -0.1206*** | -0.1218*** | -0.1256*** | -0.1228*** | -0.1255*** | -0.1186*** | -0.1230*** |
| | (0.0272) | (0.0268) | (0.0268) | (0.0266) | (0.0265) | (0.0266) | (0.0265) | (0.0265) | (0.0265) |
| Volatility of T-Bill rate | -1.0736*** | -1.0408** | -1.0828*** | -1.1582*** | -1.1878*** | -1.1661*** | -1.1887*** | -1.1074*** | -1.1380*** |
| | (0.4160) | (0.4139) | (0.4142) | (0.4111) | (0.4112) | (0.4110) | (0.4111) | (0.4196) | (0.4197) |
| Term spread | -1.5011*** | -1.4894*** | -1.4962*** | -1.4861*** | -1.4916*** | -1.4738*** | -1.4763*** | -1.4678*** | -1.4745*** |
| | (0.0995) | (0.0994) | (0.0989) | (0.0975) | (0.0970) | (0.0976) | (0.0972) | (0.0972) | (0.0968) |
| Credit spread | 0.8937*** | 0.9022*** | 0.8899*** | 0.8267*** | 0.8200*** | 0.8524*** | 0.8467*** | 0.8641*** | 0.8578*** |
| | (0.2806) | (0.2803) | (0.2804) | (0.2782) | (0.2782) | (0.2781) | (0.2781) | (0.2809) | (0.2809) |
| Obs | 9121 | 9121 | 9120 | 9386 | 9385 | 9386 | 9385 | 9386 | 9385 |
| Pseudo $R^2$ | 0.2622 | 0.2624 | 0.2645 | 0.2631 | 0.2626 | 0.2623 | 0.2631 | 0.2652 | 0.2643 |

Theoretically, maturity gap is the difference in the weighted maturity of long- and short- term assets versus liabilities. Since the data is not detailed enough to construct the exact measure for maturity gap, we follow Flannery and James (1984) to use the difference between the dollar value of assets subject to re-pricing within one year and the dollar value of liabilities to be re-priced within the same the period. The effect of this approximation is that we now effectively measure the gap between short term assets and short term liabilities with the same maturity, whose sensitivity to interest rate movement shall be the same. As a result, the movement in interest rate would have the same effect on the discount rate applied to both the assets and liabilities approximated by our measurements. As a consequence of this inevitable approximation, the part of maturity gap that results from the mismatch between short term liabilities and long term assets is not being conditioned upon. The impact of the remaining part of maturity mismatch on the likelihood of derivative use appears to be picked up by the term spread.

Loan sales and securitization have been studied in the context of credit risk transfer (see Kiff, Michaud and Mitchell 2002 and Minton, Stulz and Williamson 2006) and are shown to be alternatives to derivatives when the lemon problem and relationship lending are not of concern. To the extent that loan sales and securitization alter the bank's balance sheet structure and reduces the interest rate exposure of assets by removing some loans from the balance sheet, they can also be the alternative to interest rate derivatives in satisfying the bank's hedging needs. Implicitly here is that the presence of loan sales and securitization also indicates the opportunity or necessity of a bank to reduce its interest rate or credit risk exposure. Our results show that the dummy variable of loan sale has a significantly positive relation with the likelihood of hedging using interest rate derivatives. This should be understood as saying that banks/quarters that use loan sale corresponds closely to the situations where the need for hedging using interest rate derivative is also present, which result in the parallel use of derivatives and loan sales in those bank/quarters. Securitization however does not appear to offer meaningful explanatory power.

The measures of profitability we investigate include return on asset, return on equity and interest margin (the ratio of net interest income to total asset). Although all measures have positive signs, only ROE appears to be statistically significant. Such a strong and positive impact of ROE on the likelihood of hedging with derivatives can be seen as saying that as the bank becomes more valuable to the shareholders, the need to preserve such profitability, or the charter value of the bank, increases which in turn results in more hedging activity. Nonperforming assets only demonstrate a weak positive relation on the hedging activity of banks.

### 3.5.2 Hedging with credit derivative

Table VI reports the estimation output for the likelihood of hedging with credit derivatives. This likelihood primarily and consistently depends on two factors, the size of the bank and if the bank participates in the trading of credit derivatives. These are consistent with the literature on the use of credit derivative for hedging that shows that large banks are the predominant user of credit derivatives (see e.g., OCC 2005, and Minton, Stulz and Williamson 2006). Also consistent with the literature are the negative impact of interest margin and total deposit ratio, and the positive effect of securitization on the use of credit derivatives (Minton, Stulz and Williamson 2006). Loan commitment appears to have small albeit consistently negative coefficients. This finding lends some support to the conjecture that loan commitment reduces the risk of banks (Boot and Thakor 1991) in that if loan commitment reduces the risk exposure of banks, the need to engage in hedging with derivatives should decrease.

Yet we are unable to confirm other findings in the paper by Minton Stulz and Williamson. In particular, we did not find a trace of positive impact of loan measures[11] on the use of credit derivatives; the effect of loan sales is inconsistent in signs across different conditioning sets and never significant. Among the possible reasons for this disparity, the different sample period and modeling methodology may be the most important.

[11] In the paper by Minton, Stulz and Williamson (2006) various categories of loans are scaled by total loans. In our study, we use total asset for the scaling purpose. However, our results still hold if we use total loans to scale C&I loans and other loans.

**Table VI**
**To Use or not to Use Credit Derivatives: Conditional Logit Panel Data Model with Binary Outcome**

This table reports the estimation output of the conditional logit model with the binary outcome of hedging with *credit derivative* as the dependent variable. The Models are estimated based on Chamberlain (1980). Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Tier 1 ratio | 0.2482 | 0.2422 | 0.2474 | 0.2428 | 0.2507 | 0.2865 | 0.2936 | 0.2391 | 0.2470 |
| | (0.1585) | (0.1758) | (0.1773) | (0.1844) | (0.1834) | (0.2158) | (0.2057) | (0.1833) | (0.1816) |
| Loan sale | 0.2239 | 0.0035 | 0.0921 | -0.0573 | 0.0744 | 0.1193 | 0.2470 | -0.0525 | 0.0860 |
| | (1.0630) | (1.1773) | (1.0544) | (1.1751) | (1.0156) | (1.1206) | (0.9738) | (1.1664) | (1.0136) |
| Securitization | 0.8958 | 1.0544* | 0.9782 | 0.9335 | 0.8616 | 1.1553* | 1.0590 | 0.9574 | 0.8805 |
| | (0.6425) | (0.6155) | (0.6643) | (0.5937) | (0.6421) | (0.5895) | (0.6459) | (0.5990) | (0.6490) |
| Size | 3.6521*** | 3.6633*** | 3.6704*** | 3.6761*** | 3.7036*** | 4.5267*** | 4.4968*** | 3.6109*** | 3.6439*** |
| | (1.2490) | (1.2570) | (1.2398) | (1.2403) | (1.2007) | (1.2328) | (1.1833) | (1.2537) | (1.2156) |
| ROA | -0.0297 | -0.0435 | -0.0498 | | | | | | |
| | (0.1799) | (0.1969) | (0.1978) | | | | | | |
| ROE | | | | -0.0120 | -0.0113 | -0.0082 | -0.0069 | | |
| | | | | (0.0208) | (0.0204) | (0.0204) | (0.0200) | | |
| Interest margin | | | | | | | | -0.1575* | -0.1392* |
| | | | | | | | | (0.0823) | (0.0834) |
| Total loan ratio | -0.1457 | | | | | | | | |
| | (0.0893) | | | | | | | | |
| C&I loan ratio | | -0.1171 | | -0.1368 | | -0.1267 | | -0.1399 | |
| | | (0.0842) | | (0.0908) | | (0.0828) | | (0.0902) | |
| Other loan ratio | | | 0.0049 | | -0.0034 | | -0.0128 | | -0.0016 |
| | | | (0.0589) | | (0.0575) | | (0.0570) | | (0.0579) |
| Liquid asset ratio | -0.1536* | -0.0432 | -0.0230 | -0.0275 | -0.0123 | -0.0223 | -0.0158 | -0.0289 | -0.0120 |
| | (0.0853) | (0.0644) | (0.0645) | (0.0568) | (0.0610) | (0.0542) | (0.0604) | (0.0574) | (0.0616) |

(*Continued*)

**Table VI Continued**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Total deposit ratio | -0.0916 | -0.1037* | -0.1071 | | | | | | |
| | (0.0665) | (0.0630) | (0.0656) | | | | | | |
| Demand deposit ratio | | | | -0.1374 | -0.1237 | | | -0.1386 | -0.1248 |
| | | | | (0.0963) | (0.0953) | | | (0.0961) | (0.0955) |
| Transaction account ratio | | | | | | 0.1922** | 0.1980** | | |
| | | | | | | (0.0882) | (0.0888) | | |
| Gap ratio | 0.0174 | 0.0215 | 0.0195 | 0.0056 | 0.0037 | 0.0145 | 0.0113 | 0.0045 | 0.0027 |
| | (0.0247) | (0.0259) | (0.0250) | (0.0241) | (0.0235) | (0.0235) | (0.0230) | (0.0245) | (0.0240) |
| Non-perform asset ratio | -0.8689 | -0.9652 | -1.0900 | -0.9147 | -1.0496 | -0.8731 | -1.0070 | -0.8752 | -1.0210 |
| | (1.1755) | (1.2534) | (1.2372) | (1.2021) | (1.1763) | (1.1574) | (1.1268) | (1.2194) | (1.1937) |
| Unused commitment | -0.0448 | -0.0383 | -0.0552 | -0.0328 | -0.0554 | -0.0365 | -0.0571 | -0.0315 | -0.0550 |
| | (0.0415) | (0.0356) | (0.0436) | (0.0337) | (0.0444) | (0.0360) | (0.0440) | (0.0339) | (0.0445) |
| Trade credit derivative | 4.1324*** | 4.1233*** | 4.1659*** | 4.0490*** | 4.1350*** | 4.1955*** | 4.2807*** | 4.0484*** | 4.1305*** |
| | (0.8213) | (0.8305) | (0.8249) | (0.9114) | (0.9119) | (0.8656) | (0.8596) | (0.9124) | (0.9082) |
| T-Bill rate | -0.1047 | -0.1017 | -0.1958 | -0.0477 | -0.1644 | -0.1202 | -0.2291 | -0.0462 | -0.1636 |
| | (0.1779) | (0.1844) | (0.1751) | (0.2027) | (0.1947) | (0.1763) | (0.1741) | (0.2011) | (0.1944) |
| Volatility of T-Bill rate | 1.4864 | 1.5512 | 1.1484 | 1.8893 | 1.4009 | 1.5805 | 1.0986 | 2.2077 | 1.6729 |
| | (1.4994) | (1.4534) | (1.4235) | (1.5066) | (1.4727) | (1.5156) | (1.4961) | (1.4981) | (1.4742) |
| Term spread | -0.5423 | -0.5378 | -0.6797 | -0.2731 | -0.4476 | -0.4524 | -0.6031 | -0.2785 | -0.4538 |
| | (0.4568) | (0.4527) | (0.4337) | (0.5005) | (0.4797) | (0.4826) | (0.4661) | (0.4998) | (0.4789) |
| Credit spread | -0.2970 | -0.5145 | -0.5254 | -0.1866 | -0.2175 | -0.4779 | -0.4805 | -0.0570 | -0.1076 |
| | (0.7668) | (0.7852) | (0.7472) | (0.7081) | (0.6722) | (0.7250) | (0.6949) | (0.7094) | (0.6745) |
| Obs | 1071 | 1071 | 1071 | 1083 | 1083 | 1082 | 1082 | 1083 | 1083 |
| Pseudo $R^2$ | 0.419 | 0.417 | 0.4103 | 0.4101 | 0.4106 | 0.4168 | 0.4097 | 0.4117 | 0.4028 |

### 3.6 The adjustment in hedging with derivatives as ordered multinomial responses

With the above binary estimation we answered the question why a BHC hedges with derivatives in some periods but not in others. A disadvantage of the above methodology is that being forced to consider only those BHCs that switch their derivative-use status at least once we had to discard those cross-sections that have used derivative for the entire sample period and lost valuable information. Furthermore, with binary choice we cannot observe the fine-tuning of derivative holdings by BHCs and its underlying determinants. In other words, we cannot answer the question what makes BHCs increase or decrease their derivative hedging from the previous periods, or keep their derivative hedging unchanged. To shed lights on these more detailed activities, we further our analysis with an ordered multinomial model. In particular, we specify the following five categories of derivative adjustments by BHCs corresponding to different actions taken on their current derivative engagement from the previous quarter. Let $D_t$ denote the notional amount of a BHC's derivative holding,

$$
y_{it} = \begin{cases} 1 & \text{if } D_{t-1} = D_t = 0 \\ 2 & \text{if } D_{t-1} > D_t = 0 \\ 3 & \text{if } D_{t-1} > D_t > 0 \\ 4 & \text{if } D_{t-1} = D_t > 0 \\ 5 & \text{if } D_t > D_{t-1} \geq 0 \end{cases}
$$

Note that there is a clear ordering in these mutually exclusive specifications. While the ordering is not in terms of the actual notional amount, we can interpret them as follows: from 1 to 5, the need or perceived benefit of hedging with derivatives increases. Note that we do not distinguish between the two cases where a BHC either increases its derivative holding from nil, or increases its existing derivative holding. It is hard to argue which has a higher ranking; but compared with the other four alternatives both cases represent the strongest willingness or benefit to use derivative for hedging. With this ordered multinomial specification, we not only more explicitly model the specific nature of actions taken on the derivative position of the BHCs on a quarterly basis, but also expand the sample to include those BHCs that use derivatives for their whole available sample period. As in the binary case, we use an unbalanced panel in an effort to preserve all information we have. Note that since the dependent variable now has reference to the previous quarter, we use the first difference of the explanatory variables in the estimation. The later interpretation will then be in terms of the impact of the magnitude of the changes in the BHC specific variables and the macroeconomic factors from the previous quarter on the adjustment of derivatives held for hedging from the previous quarter.

The conditional likelihood functions now include the sum of the number of quarters when a BHC adopts each one of the five mutually exclusive adjustment alternatives in the conditioning set. In other words, the new likelihood function is conditioned on, in additional to the explanatory variables and the coefficients in β, five sums, one for each of the five adjustment alternatives specified above. Like in the binary case, we are only interested in those BHCs that have altered their derivative position at least once. That is, at least two of the five alternatives in $y_{it}$ must appear in all available T for a BHC to be included. This means we include all BHCs that have derivative holdings in at least one of the quarters during our sample period. Note that even if a BHC used derivative in only one quarter, there would be two values in $y_{it.}$ For example, if a BHC used derivative only in t, then $y_{i,t} = 4$ because from t-1 to t, the derivative holding increases; then $y_{i,t+1} = 2$, because its derivative holding decreases to zero during the period from t to t+1. The model specification can now be formulated as

$$y_{it} = d_k \leftrightarrow s_i^d \leq y^*_{it} \leq s_i^{d+1} \qquad (1)$$
$$\text{where } y^*_{it} = X_{it}\,\beta + \alpha_i + \varepsilon_{it}$$

In our specification, $d_k$ = 1 to 5, representing the different degrees of change in the engagement in derivatives for hedging purpose. $S_i$ is the threshold for a bank-quarter observation to correspond to a particular $d_k$ value. The value of $S_i$ is specific to BHC and invariable across the time dimension for a BHC. This threshold is regulated by the underlying latent $y^*_{it}$, which is a function of $X_{it}$, the vector of explanatory variables we chose and $\alpha_i$ that captures the BHC specific fixed-effect. $\varepsilon_{it}$ has the logistic distribution and is assumed to be unobserved factors uncorrelated with $x_{it}$. Note we can specify either $\alpha_i$ or $S_i$ to be BHC specific, or both. The point is because of the presence of the BHC specific effect the threshold for various $d_k$ differs across BHCs.

The challenge in estimating this specification is that compared with the classical Chamberlain (1980) specification on the conditional logit model, specification (1) require multiple threshold parameters and the joint probability of $y_{it} = d_{k,i,t=1} \ldots d_{k,i,t=T}$ for all $d_k$ values. The inclusion of the joint probability would involve the BHC specific effect appearing in multiple occasions in the conditioning set for the likelihood function, which cannot be eliminated by the Chamberlain methodology. In particular, the likelihood function now becomes

$$P\left[ y_{i,t} = d_k \ldots y_{it=T} = d_k \mid \sum_{d_k=1}^{d_k=5} y_i \right]$$

This likelihood function has the sum of $y_i$ equal a particular $d_k$ value for all $d_k$ values over the available T that are observed in the $y_{it}$ series. Therefore, the BHC specific parameter appears in each of the cases where a different $d_k$ value appears. The Chamberlain (1980) methodology however can not distinguish more than two alternatives. The consequence is that the knowledge on the number of times all possible $d_k$ value occurred as reflected in $y_{it}$ does not allow us to uniquely separate one set of $y_{it}$ that corresponds to a $d_k$ value from the sets of $y_{it}$ that correspond to all other $d_k$ values[12].

To solve the problem, we adopt the extension by Ferrer-i-Carbonell and Frijters (2004) on the Chamberlain (1980) model into the ordered multinomial case. Ferrer-i-Carbonell and Frijters (2004) solve this issue by introducing a new parameter in the likelihood function $C_{it}$ and transform the multivariate model into a binary one. $C_{it}$ is a matrix composed with rows of binary variables that equals to one if the observed $y_{it}$ is larger than a particular $d_k$ value. If all $d_k$ values are used, we have a maximum of four rows in the matrix, representing those $y_{it}$ that are larger than 1, than 2, than 3, and than 4, respectively. The number of columns depends on the number of quarters a BHC has observations. For example, if we observe a $y_{it}$ sequence for a BHC that has three quarterly observations, or $y_{it}$ = {1, 2, 5}, the transformed sequence will become $\mathbf{C}'_{it} = \{C'_{i,t,k}\} = \left\{ \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \right\}$, which correspond to $y_{it}>1$, $y_{it}>2$, $y_{it}>4$. (The index K is the number of the values $d_k$ can take, or K=5). Now, the original $y_{it}$ series is transformed into three binary variables. Apply this transformation to all BHCs, we transform all observations into binary variables and expand the dependent variable by either T, the available quarters of observations for a BHC, or K-1=4, corresponding to $y_{it}>1$ to $y_{it} >4$, whichever is the lowest. The conditional likelihood function for each BHC now, depending on what values of $d_k$ appear in the observed $y_{it}$ series, becomes

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[12] Note that if there are only two observations available for a BHC, the ordered multinomial specification collapses to a binary case where the Chamberlain (1980) methodology can also be applied.

$$P\left[ y_{i,t} = C_{it} \mid \sum y_{it}, X_{it}, \beta, \alpha_i \right] \text{ for } y_{it} > D_k \quad (2)$$

The $C_{it}$ in specification (2) is one of the columns in the matrix $\mathbf{C}_{it}$, which encompasses the transformed dependent variable for all appeared $D_k$ values. That is, specification (2) says that there is one likelihood function that corresponds to a particular transformation. The sufficient statistics now is the number of occurrence of one after transforming the $y_{it}$ series according to a particular $D_k$. Assuming a logistic distribution, Ferrer-i-Carbonell and Frijters show that the probability function, adapted to our case, can be written as:

$$P[C_{i,t,k} \mid \sum_t C_{i,t,k}, X_{it}, \beta] = \frac{e^{\sum_{t=1}^{T} C_{i,t,k} X_{it} \beta}}{\sum_{\sum_{t=1}^{T} C_{i,t,k}} e^{\sum_{t=1}^{T} C_{i,t,k} X_{it} \beta}} \quad (3)$$

*P* is the likelihood function, which no longer depends on the BHC specific *α*. The numerator is the likelihood of the observed sequence of $y_{it}$, after a particular transformation. The denominator is the likelihood of all possible sequence of $y_{it}$, which encompasses all four possible transformations, provided the corresponding $d_k$ values are observed. In the estimation however, only one transformation is applied to a BHC. The objective is to maximize the likelihood function with respect to the common coefficient vector β, whilst allowing different BHCs to have different conditioning set in terms of the transformation and the resulting sufficient statistics. To this end, the maximum likelihood estimator of β with the minimal variance is estimated using the Chamberlain (1980) methodology[13].

### 3.7 Results from Panel data analysis with ordered multinomial outcomes

#### 3.7.1 The adjustment of interest rate derivatives held for hedging

We use the methodology of Ferrer-i-Carbonell and Frijters (2004) to answer the question what changes in the bank balance sheet structure and macroeconomic factors make it more likely that banks increase or decrease their hedging with derivatives. Table VII A reports the results.

[13] We thank Paul Frijters for providing us with the computer program used in Ferrer-i-Carboneel and Frijters (2004).

Note that with the new methodology we are able to expand the sample size by 4000 observations reflecting the fact that we now include banks that have used interest rate derivatives for the whole sample. In the case of interest rate derivatives, one surprising finding is that higher levels of change in Tier I risk capital appears to increase the likelihood of banks to increase interest rate derivatives for hedging. The Tier I risk capital specified by Basel II accord is designed to provide a good level of cushion against the shocks on bank liquidity resulted from various categories of risk, e.g., credit risk, market risk and operational risk. To this end, there doesn't appear to be a relation between Tier I capital and interest rate risk and the need to use interest rate derivatives. However, since the calculation of Tier I capital is based on book value, the movement in interest rate may create considerable gap in Tier-I capital measured with market value (Saunders and Cornett 2005 page 573). That is, the market values of the components of Tier I capital being various categories of equity capital crucially depend on the difference between the market values of assets and liabilities. As interest rate rises, the market value of the assets would drop more than liabilities, which in turn reduces the market value of the Tier I capital. Such a development would not show in book value. In the most extreme case, the bank may become economically insolvent due to the rise in interest rate reducing the market value of assets to such an extent that the market value of the equity is wiped out. In addition, since Tier I capital also represents the shareholders' interest, the higher the Tier I capital the higher the stake the shareholders have in the bank and the more risk averse they would be. The likelihood for hedging therefore increases. This is consistent with Stulz (1984) and Smith and Stulz (1985) in the sense that shareholder/manager chooses a hedging strategy to maximize firm value. This is also consistent with Stulz (1996) in that firms hedge to reduce downside risks.

**Table VII**

**Fine-tuning of Hedging with Interest Rate Derivatives: Conditional panel logit model estimation with Ordered Multinomial Outcome**

This table reports the estimation outputs of the conditional logit model with as the dependent variable the ordered multinomial outcomes of hedging with *interest rate derivative*; the estimation uses the first the difference in the original explanatory variable except for the dummies. Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. The models are estimated using the methodology based on Ferrer-i-Carbonell and Frijters (2004). Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Δ Tier 1 ratio | 0.0497*** | 0.0494*** | 0.0498*** | 0.0538*** | 0.0538*** | 0.0537*** | 0.0536*** | 0.0533*** | 0.0532*** |
| | (0.0179) | (0.0181) | (0.0180) | (0.0182) | (0.0179) | (0.0181) | (0.0179) | (0.0180) | (0.0178) |
| Loan sale | 0.8240*** | 0.8229*** | 0.8224*** | 0.8158*** | 0.8152*** | 0.8204*** | 0.8199*** | 0.8170*** | 0.8167*** |
| | (0.1657) | (0.1656) | (0.1658) | (0.1609) | (0.1611) | (0.1610) | (0.1612) | (0.1610) | (0.1612) |
| Securitization | -0.0922 | -0.0934 | -0.0919 | -0.0553 | -0.0539 | -0.0535 | -0.0521 | -0.0559 | -0.0547 |
| | (0.1747) | (0.1745) | (0.1745) | (0.1683) | (0.1683) | (0.1681) | (0.1681) | (0.1683) | (0.1683) |
| Δ Size | 0.5731*** | 0.5649*** | 0.5896*** | 0.5316*** | 0.5506*** | 0.5293*** | 0.5472*** | 0.5279*** | 0.5474*** |
| | (0.2011) | (0.1918) | (0.2029) | (0.1786) | (0.1857) | (0.1781) | (0.1849) | (0.1784) | (0.1852) |
| Δ ROA | -0.0224 | -0.0216 | -0.0226 | | | | | | |
| | (0.0235) | (0.0235) | (0.0236) | | | | | | |
| Δ ROE | | | | -0.0011 | -0.0012 | -0.0011 | -0.0012 | | |
| | | | | (0.0010) | (0.0010) | (0.0010) | (0.0010) | | |
| Δ Interest margin | | | | | | | | -0.0099 | -0.0113 |
| | | | | | | | | (0.0089) | (0.0090) |
| Δ Total loan ratio | 0.0092 | | | | | | | | |
| | (0.0085) | | | | | | | | |
| Δ C&I loan ratio | | -0.0104 | | -0.0099 | | -0.0096 | | -0.0096 | |
| | | (0.0132) | | (0.0123) | | (0.0123) | | (0.0122) | |
| Δ Other loan ratio | | | 0.0131 | | 0.0116 | | 0.0115 | | 0.0120 |
| | | | (0.0094) | | (0.0090) | | (0.0090) | | (0.0091) |
| Δ Liquid asset ratio | 0.0113 | 0.0026 | 0.0124* | 0.0049 | 0.0137* | 0.0050 | 0.0137* | 0.0049 | 0.0138* |
| | (0.0085) | (0.0081) | (0.0074) | (0.0088) | (0.0077) | (0.0087) | (0.0078) | (0.0087) | (0.0077) |

(*Continued*)

**Table VII Continued**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Δ Total deposit ratio | -0.0132* | -0.0133* | -0.0130 | | | | | | |
| | (0.0080) | (0.0080) | (0.0082) | | | | | | |
| Δ Demand deposit ratio | | | | 0.0038 | 0.0046 | | | 0.0040 | 0.0049 |
| | | | | (0.0081) | (0.0082) | | | (0.0081) | (0.0082) |
| Δ Transaction account ratio | | | | | | 0.0045 | 0.0052 | | |
| | | | | | | (0.0083) | (0.0084) | | |
| Δ Gap ratio | -0.0004 | -0.0002 | -0.0003 | -0.0003 | -0.0004 | -0.0003 | -0.0004 | -0.0003 | -0.0004 |
| | (0.0021) | (0.0021) | (0.0022) | (0.0021) | (0.0021) | (0.0021) | (0.0021) | (0.0021) | (0.0021) |
| Δ Non-perform asset ratio | -0.0757 | -0.0733 | -0.0766 | -0.0946 | -0.0975 | -0.0939 | -0.0967 | -0.0943 | -0.0973 |
| | (0.0720) | (0.0722) | (0.0720) | (0.0720) | (0.0719) | (0.0720) | (0.0719) | (0.0724) | (0.0724) |
| Δ Unused commitment | -0.0045 | -0.0040 | -0.0043 | -0.0031 | -0.0034 | -0.0031 | -0.0034 | -0.0031 | -0.0034 |
| | (0.0048) | (0.0048) | (0.0048) | (0.0048) | (0.0048) | (0.0048) | (0.0048) | (0.0048) | (0.0048) |
| Trade Interest rate derivative | -0.2704 | -0.2701 | -0.2702 | -0.2652 | -0.2658 | -0.2654 | -0.2660 | -0.2653 | -0.2659 |
| | (0.2373) | (0.2370) | (0.2372) | (0.2295) | (0.2297) | (0.2296) | (0.2298) | (0.2295) | (0.2297) |
| Δ T-Bill rate | 0.7205*** | 0.7228*** | 0.7212*** | 0.7324*** | 0.7310*** | 0.7327*** | 0.7313*** | 0.7334*** | 0.7322*** |
| | (0.0815) | (0.0814) | (0.0815) | (0.0787) | (0.0788) | (0.0788) | (0.0788) | (0.0786) | (0.0786) |
| Δ Volatility of T-Bill rate | -0.1703 | -0.1593 | -0.1708 | -0.1730 | -0.1842 | -0.1742 | -0.1850 | -0.1358 | -0.1401 |
| | (0.1636) | (0.1639) | (0.1636) | (0.1554) | (0.1549) | (0.1552) | (0.1547) | (0.1646) | (0.1642) |
| Δ Term spread | -0.3081*** | -0.3049*** | -0.3058*** | -0.2757*** | -0.2762*** | -0.2766*** | -0.2773*** | -0.2737*** | -0.2737*** |
| | (0.0594) | (0.0593) | (0.0594) | (0.0583) | (0.0584) | (0.0584) | (0.0585) | (0.0581) | (0.0581) |
| Δ Credit spread | 0.2835*** | 0.2879*** | 0.2820*** | 0.3082*** | 0.3019*** | 0.3098*** | 0.3041*** | 0.3236*** | 0.3203*** |
| | (0.0838) | (0.0837) | (0.0838) | (0.0814) | (0.0816) | (0.0812) | (0.0814) | (0.0841) | (0.0840) |
| Obs | 16900 | 16900 | 16900 | 17400 | 17400 | 17400 | 17400 | 17400 | 17400 |
| Pseudo $R^2$ | 0.0306 | 0.0306 | 0.0307 | 0.0313 | 0.0314 | 0.0314 | 0.0314 | 0.0313 | 0.0314 |

Similar with the results in the study on the binary outcomes, size appears to be significantly positive. However the interpretation here is that larger increases in the size of a bank increase the likelihood to hedge more with interest rate derivatives. Specifically, for example, the increase in size of a bank also increases the likelihood of the bank to use more interest rate derivatives for hedging, in the direction from 1 to 5 in our dependent variable formulation[14]. The theory by Allen and Santomero (1998) also applies here. As banks grow at a bigger pace the systematic risks also accumulates faster, which increase the need for banks to transfer these risks to the market.

More noticeably, the interest rate variable now becomes significantly positive. Coupled with the results from the study on binary outcomes, this means while high interest rate state reduces the need to hedge with interest rate derivative, larger increases (decreases) in interest rate increase (decrease) the magnitude of such need.

### 3.7.2 The adjustment of credit derivatives held for hedging

The adjustments in the hedging activity with credit derivatives as shown in Table VIII appear to primarily depend on the dummy variables for securitization and the participation in the trading of credit derivatives. The presence of securitization indicates the existence of assets whose risks may be laid off in the financial markets. In other words, the existence of securitization implies that there are credit risks on the bank balance sheet the financial markets are willing and capable of taking over. These risks seem also give rise to the necessity to hedge with credit derivatives. Or the use of securitization and credit derivatives are likely to be applied at the same time for the same purpose, i.e., to lay off credit risks to the financial market.

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[14] For each BHC, a significantly positive covariate shifts part of the probability mass from the region corresponding to the first rank to the fifth and thereby increases likelihood of the occurrence of higher ranking events. Exactly which region is increased unfortunately cannot be determined. In addition, the region thresholds also differ among individual BHCs as a result of the specification in equation 1.

**Table VIII**
**Fine-tuning of Hedging with Credit Derivatives: Conditional panel logit model estimation**
**With Ordered Multinomial Outcome**

This table reports the estimation outputs of the conditional logit model with as the dependent variable the ordered multinomial outcomes of hedging with *credit derivative*; the estimation uses the first the difference in the original explanatory variable except for the dummies. Model 1 to model 3 use ROA to measure bank profitability but differ by the loan ratios used. Model 4 to model 7 uses ROE to measure profitability but differ by the loan ratios and deposit ratios used. Model 8 and Model 9 use interest margin to measure profitability but differ by loan ratios and deposit ratios. The models are estimated using the methodology based on Ferrer-i-Carbonell and Frijters (2004). Robust standard errors that control for heteroskedasticity are reported in the brackets. Refer to Appendix for the definition and construction of the variables.

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Δ Tier 1 ratio | -0.0816* | -0.0795* | -0.0855* | -0.0650 | -0.0753 | -0.0650 | -0.0748 | -0.0669 | -0.0774 |
| | (0.0461) | (0.0453) | (0.0447) | (0.0515) | (0.0500) | (0.0516) | (0.0500) | (0.0522) | (0.0505) |
| Δ Loan sale | -0.1616 | -0.1767 | -0.1825 | -0.1682 | -0.1808 | -0.1927 | -0.2057 | -0.1610 | -0.1728 |
| | (0.6741) | (0.6714) | (0.6775) | (0.6642) | (0.6725) | (0.6585) | (0.6668) | (0.6644) | (0.6722) |
| Δ Securitization | 1.2646** | 1.2621** | 1.2642** | 1.2572** | 1.2568** | 1.2580** | 1.2572** | 1.2498** | 1.2481** |
| | (0.5102) | (0.5090) | (0.5094) | (0.5034) | (0.5036) | (0.5030) | (0.5033) | (0.5028) | (0.5027) |
| Δ Size | -0.1116 | -0.2028 | -0.0463 | -0.3499 | -0.1394 | -0.3443 | -0.1440 | -0.3517 | -0.1432 |
| | (0.8431) | (0.7963) | (0.7768) | (0.7780) | (0.7499) | (0.7818) | (0.7513) | (0.7785) | (0.7516) |
| Δ ROA | 0.0425 | 0.0358 | 0.0307 | | | | | | |
| | (0.0901) | (0.0858) | (0.0890) | | | | | | |
| Δ ROE | | | | -0.0048 | -0.0054 | -0.0045 | -0.0051 | | |
| | | | | (0.0087) | (0.0087) | (0.0087) | (0.0087) | | |
| Δ Interest margin | | | | | | | | -0.0259 | -0.0315 |
| | | | | | | | | (0.0446) | (0.0452) |
| Δ Total loan ratio | -0.0040 | | | | | | | | |
| | (0.0442) | | | | | | | | |
| Δ C&I loan ratio | | -0.0424 | | -0.0419 | | -0.0406 | | -0.0414 | |
| | | (0.0806) | | (0.0766) | | (0.0789) | | (0.0761) | |
| Δ Other loan ratio | | | 0.0271 | | 0.0371 | | 0.0357 | | 0.0376 |
| | | | (0.0456) | | (0.0449) | | (0.0453) | | (0.0459) |
| Δ Liquid asset ratio | -0.0291 | -0.0294 | -0.0110 | -0.0331 | -0.0085 | -0.0335 | -0.0098 | -0.0336 | -0.0089 |
| | (0.0378) | (0.0262) | (0.0353) | (0.0263) | (0.0345) | (0.0263) | (0.0345) | (0.0263) | (0.0352) |

(*Continued*)

**Table VIII Continued**

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|---|---|---|---|---|
| Δ Total deposit ratio | 0.0260 | 0.0284 | 0.0237 | | | | | | |
| | (0.0264) | (0.0262) | (0.0262) | | | | | | |
| Δ Demand deposit ratio | | | | 0.0304 | 0.0307 | | | 0.0311 | 0.0315 |
| | | | | (0.0522) | (0.0523) | | | (0.0523) | (0.0524) |
| Δ Transaction account ratio | | | | | | 0.0190 | 0.0156 | | |
| | | | | | | (0.0503) | (0.0502) | | |
| Δ Gap ratio | -0.0096 | -0.0090 | -0.0086 | -0.0075 | -0.0070 | -0.0077 | -0.0072 | -0.0077 | -0.0072 |
| | (0.0099) | (0.0096) | (0.0098) | (0.0093) | (0.0094) | (0.0093) | (0.0094) | (0.0093) | (0.0094) |
| Δ Non-perform asset ratio | -0.1881 | -0.1663 | -0.1998 | -0.1855 | -0.2280 | -0.1828 | -0.2228 | -0.1797 | -0.2204 |
| | (0.4038) | (0.3928) | (0.4043) | (0.3891) | (0.4065) | (0.3862) | (0.4036) | (0.3853) | (0.4025) |
| Δ Unused commitment | 0.0019 | 0.0026 | 0.0018 | 0.0028 | 0.0020 | 0.0031 | 0.0023 | 0.0028 | 0.0021 |
| | (0.0141) | (0.0139) | (0.0140) | (0.0138) | (0.0139) | (0.0136) | (0.0138) | (0.0138) | (0.0139) |
| Trade credit derivative dummy | 2.1392*** | 2.1347*** | 2.1391*** | 2.1298*** | 2.1343*** | 2.1212*** | 2.1250*** | 2.1275*** | 2.1318*** |
| | (0.6300) | (0.6295) | (0.6287) | (0.6319) | (0.6303) | (0.6350) | (0.6333) | (0.6335) | (0.6320) |
| Δ T-Bill rate | 0.3104 | 0.3274 | 0.3159 | 0.3448 | 0.3340 | 0.3403 | 0.3301 | 0.3436 | 0.3335 |
| | (0.2669) | (0.2690) | (0.2645) | (0.2682) | (0.2628) | (0.2683) | (0.2633) | (0.2679) | (0.2625) |
| Δ Volatility of T-Bill rate | -0.4776 | -0.4796 | -0.4641 | -0.3326 | -0.3280 | -0.3046 | -0.2986 | -0.2902 | -0.2704 |
| | (0.5438) | (0.5448) | (0.5408) | (0.5762) | (0.5732) | (0.5773) | (0.5739) | (0.5620) | (0.5571) |
| Δ Term spread | -0.2551 | -0.2524 | -0.2478 | -0.2181 | -0.2124 | -0.2318 | -0.2259 | -0.2141 | -0.2069 |
| | (0.2160) | (0.2168) | (0.2188) | (0.2119) | (0.2135) | (0.2140) | (0.2158) | (0.2091) | (0.2110) |
| Δ Credit spread | 0.2847 | 0.2934 | 0.2767 | 0.3337 | 0.3117 | 0.3651 | 0.3440 | 0.3488 | 0.3334 |
| | (0.3113) | (0.3108) | (0.3139) | (0.3261) | (0.3312) | (0.3149) | (0.3199) | (0.3298) | (0.3317) |
| Obs | 1309 | 1309 | 1309 | 1320 | 1320 | 1318 | 1318 | 1320 | 1320 |
| Pseudo $R^2$ | 0.0843 | 0.0847 | 0.0847 | 0.0837 | 0.084 | 0.082 | 0.0824 | 0.0836 | 0.084 |

The involvement in the trading of credit derivatives means the banks take on some risks that the counterparties default. This is true when banks sells protection for a fee and when acting as intermediaries between two other firms. These risks are normally hedged by entering into other derivatives. Therefore, it is not surprising to see that the increased use of credit derivatives for hedging is positively affected by these trading activities.

### 3.8 Concluding remarks

In this chapter we examine the use of interest rate and credit derivative for hedging by U.S. bank holding companies (BHCs). We put particular emphasis on the contribution of banks' loan making activities, both on- and off- balance sheet, to the likelihood of use of derivatives for hedging purposes. In particular, we investigate in a panel data setting how the variations in various categories of loans in a comprehensive panel of BHCs determine the likelihood of hedging with interest rate and credit derivative activities. We also examine to what extent interest rate and credit risks, the fundamental sources of the need for a BHC to hedge, explain the use of derivatives for hedging. We are motivated by the dramatically deepening involvement of banks in the derivative market for hedging and our limited knowledge regarding the relation of such involvement with banks' liquidity creation function, i.e., loan making activities.

We found that while the on-balance sheet loans have little to do with banks engagement in interest rate and credit derivative, the increase in the off-balance sheet loan commitment appears to significantly increase the likelihood of a bank to become an interest rate derivative user for hedging. We also demonstrate the significant dampening effect of interest rates and term spread on the likelihood of hedging with interest rate derivatives. We explain this phenomenon by considering the interaction between the maturity gap and interest rates movements. As interest rate rises, the market value of any maturity gap becomes smaller which reduces interest rate risk exposure and the need for hedging.

The use of credit derivatives is mainly determined by banks' engagement in the trading of credit derivatives. Size and the ratio of transaction account also play a role in determining if a bank becomes a derivative user or not for hedging. More profitable banks, as measured by interest margin, are less likely to be a derivative user for hedging.

One limitation of our study is that we do not explicitly study the potential relation between IR derivative use and credit derivative use. Schrand and Unal (1998) argue that the management of credit risk and interest-rate risk is intermingled. Rather than viewing each source of risk separately, financial institutions should engage in joint risk management. Schrand and Unal suggest that credit risk can be managed through the selection of various interest-sensitive assets (e.g., loans) based on the likelihood of default while the interest-rate risk associated with interest-sensitive assets can then be managed through the use of derivatives or duration matching or both. While we do not explicitly model the potential joint determination of derivative use for interest rate and credit risk, we do explicitly incorporate various BHC balance sheet features in the likelihood function of derivative use. In addition, to the extent that the same explanatory variable is important in contributing to the likelihood of the use of IR derivative and the use of credit derivative, we implicitly show the (dis)similarity and connection between their determining mechanisms.

## Appendix: Variables and their construction

This appendix lists the variables we used in the empirical study and their construction. All bank holding companies data items are from the Consolidated Financial Statements for Bank Holding Companies FR Y-9C filings maintained by the Federal Reserve Bank of Chicago. All items are available on a quarterly basis. The sample period starts in 1997 Quarter 1 and ends 2005 Quarter 4. The interest rate, term spread and credit spread items are found on the historical statistical release by the Federal Reserve Board or Governors.

### Dependent variables

**Interest rate derivatives held for hedging**: discrete variable that is based on the values of the variable BHCK8725 (before and incl. 2000 + BHCK8729). These items report the notional amount of interest rate derivatives held for hedging purposes[15].

**Credit derivatives held for hedging**: discrete variable that is based on the value of the variable BHCKa535. These items report the notional amount of credit derivatives on which the reporting banking holding company or any of its subsidiaries is the beneficiary.

### Independent variables

**Size**: natural logarithm of total asset BHCK2170.

**Tier-1 capital ratio**: Tier 1 capital BHCK8274 divided by total asset.

**ROA**: return on asset. Net income BHCK4340 divided by total asset.

[15] See Data dictionary part II on http://www.chicagofed.org/economic_research_and_data/bhc_data.cfm.

**ROE**: return on equity. Net income divided by total equity BHCK3210.

**Interest margin**: Net interest income BHCK4074 divided by total asset.

**Total loan ratio**: Total loan BHCK2122 divided by total asset.

**Total C&I loan ratio**: the sum of total U.S. C&I (commercial and industrial) loan BHCK1763 and total non-U.S. C&I loan BHCK1764, divided by total asset.

**Total other loan ratio**: total loan – (total C&I loan + loan to foreign banks BHCK1296 + loan to foreign government and institutions including central banks BHCK2081), then divided by total asset.

**Liquid asset ratio**: (Non-interest bearing currency & coin BHCK0081 + interest bearing balances in U.S. offices BHCK0395 + interest bearing balance in non-U.S. offices BHCK0397 + funds agreed to resell BHCKB989 + held-to-maturity securities BHCK1754 + available for sale securities BHCK1773) / total asset. (The item BHCKB989 had the code BHCK1350 in years from 1997 to 2001.)

**Total deposit ratio**: the sum of interest bearing deposits in domestic BHDM6631and foreign BHFN6631 offices and non-interest bearing deposits in domestic BHDM6636 and foreign BHFN6631 divided by total asset.

**Demand deposit ratio**: demand deposit BHCB2210 divided by total asset.

**Transaction account ratio**: the sum of transaction accounts BHCB3187 BHOD3189 divided by total asset.

**Gap ratio**: maturity gap divided by total asset. Maturity gap is calculated as follows: Short term deposit liability to be re-priced or mature within on year + the portion of long-term liability to be re-priced within one year) - earning assets to be re-priced or mature within one year.

**Non-performing asset ratio**: the sum of loans, leases and other assets past due 90 days or more still accruing BHCK5525 and non-accruing BHCK5526 divided by total asset.

**Unused commitment ratio**: (Credit card line BHCK3815 + commitments to fund commercial real estate, construction, and land development loans not secured by real estate BHCK6550 + other unused commitment BHCK3818) / total asset.

**Loan sale dummy**: dummy variable that takes value 1 if the variable Loan or lease held for sale BHCK5369 is larger than zero, and 0 otherwise.

**Securitization dummy**: dummy variable that takes value 1 if either of the variable BHCK3534 (pass-through) or BHCK3535 (other) is larger than zero, and 0 otherwise.

**Interest rate**: 3-month Treasury bill rate.

**Interest rate volatility**: the monthly standard deviation of the 3-month Treasury bill rate after adjustments using the Schwert (1989) methodology (see footnote 9).

**Term spread**: the residual of the regression of the difference between 10 year Treasury bill rate and one year Treasury bill rate on interest rate and a constant.

**Credit spread 1**: the residual of the regression of the difference between 3-month AA non-financial commercial paper and 3-month T-Bill rate (Paper bill spread) on interest rate and a constant.

**Credit spread 2**: the residual of the regression of the difference between AAA corporate bond rate and BAA corporate bond rate on interest rate and a constant.

## Chapter 4

## Equity Capital, Market Power and Bank Liquidity Creation [16]

### 4.1 Introduction

The European banking industry has a number of special features that deserve examinations. First, the European financial markets are considered bank-based systems (see, e.g., Allen and Gale (2000), Allen et al (2006)) where banks are the major liquidity providers for business. Yet whether or not European banks indeed outperform their U.S. counterparts, which are thought to operate in a market based financial system, remains an insufficiently addressed question. Second, the competitive landscape of the European banking sector has gone through dramatic changes in the past couple of decades following regulatory developments. In particular, the Second Banking Directive adopted by European Union (EU) in 1995 allowed banks to freely operate in other EU countries by setting up branches or directly offering a full range of banking services. These regulations have implications on both the level of competition of the banking sector as a whole and the competitive position of individual banks in particular. How the liquidity creation activities of banks relate to these competition issues remains unclear. Next, the attitudes towards banking stability held by European and the U.S. governments are quite different. While it is a firm belief in Europe, founded on the many rescues orchestrated by European governments of their domestic banks and a more socialist ideology, that banks in Europe will not be allowed to fail so that depositors would suffer losses, bank failures in the U.S. take place more often[17]. Such a contrast in regulatory ideologies raises the question regarding the role of banks' own equity capital as a cushion against bank failures or banking risks in general. The empirical substantiation of this issue has profound policy implications on

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[16] This chapter is based on Berger et al (2009).

[17] According to Federal Deposit Insurance Corporation, there were 24 bank failures in U.S. in the period from October 2000 to 2004, which is the longest overlapping period we can find with our sample. While there is no such a comprehensive list of bank failure for Europe, the authors are not aware of a comparable number of European bank failures. In the 1980s, there were more than 1400 savings and loans institutions and 1300 banks that failed in the U.S., a magnitude unimaginable in Europe. It is also interesting to note that during the subprime crisis and the ensuing global financial crisis, there are 68 bank failures in U.S. in 2008 and the first half of 2009. In Europe however, Northern Rock in the U.K. is, to the best of our knowledge, the only bank that is allowed to fail. The governments of Belgium, Germany, Luxembourg and the Netherlands, etc., have all played direct role in rescuing endangered banks and, in the case of Fortis Bank, have cooperated across national borders.

bank capital regulation. Finally, the EU is composed with a group of countries with widely diverse institutions. In particular, the coverage of deposit insurance, the strength of creditor protection, and legal origins all find themselves a wide spectrum in EU. The direct impact of these factors and the impact of these factors possibly interacted with other factors on bank liquidity creation are also directly examined or controlled for in this paper.

In order to address the above research questions, we construct a unique dataset of banks for all 25 EU countries with detailed balance sheet data. As in Berger and Bouwman (2009), we measure liquidity creation for each individual bank by aggregating bank balance sheet items weighted by their liquidity characteristics. Specifically, we adopt the principle that €1 of liquidity is created when €1 of liquid liability is used to finance €1 of illiquid asset, and €1 of liquidity is destroyed if €1 of illiquid liability is used to finance €1 of liquid asset. We classify all bank balance sheet items into three classes, liquid, semi-liquid, and illiquid, based on the criteria how easily they can be converted into cash. Next, we assign weights to each of the classes. Liquid items are given a weight of 0.5, semi liquid items receive zero weight, and illiquid items receive a weight of -0.5. Finally, we sum all weighted items together to arrive at the amount of liquidity the bank creates. We take into account both on- and off- balance sheet items to embody the theories that banks create liquidity both with on-balance sheet operations (see e.g., Bhattacharya and Thakor 1993) and via instruments off-balance sheet (see e.g., Kashyap, Rajan, and Stein 2002). Our dataset contains the majority of banks in each individual country, which allows us to measure the level of concentration of a particular banking market as well as the market share of each individual bank in the market. We also distinguish between the old EU countries (hereafter EU15) and the newly admitted EU countries (hereafter Ascending EU), as well as between large and small banks. These distinctions help us disentangle possible institutional and structural differences between different groups of countries and banks.

Overall, our liquidity creation measure confirms that the financial system in EU is more of a bank-based system than in the U.S., as evidenced by a much higher ratio of liquidity creation to GDP in EU than in U.S. Equity capital is found to have strong and negative association with liquidity creation, especially for all small banks and large banks in EU15. Market share is consistently beneficial to liquidity creations except for small banks in Ascending EU. These results are generally robust to the control of creditor rights, bank ownership, and legal origins.

We motivate our empirical studies by the following theoretical frameworks. First, the success of bank liquidity creation is determined not only by banks' investment but their source of financing as well (Berger and Bouwman (2009)). Banks only create liquidity when they finance illiquid assets with liquid liabilities. If the European financial systems are indeed bank-based, it then may be the case that European banks have more illiquid and risky loans on the asset side of their balance sheets. In the meantime, the protection of banks by European governments are recognizably stronger than in U.S. (Benink and Benston 2005), which may render the liability side of bank balance sheet more illiquid as depositors do not require as much ability to withdraw their deposits in distress, i.e., to run on their banks. Therefore, the success of European banks in liquidity creation depends on whether illiquid assets outweigh illiquid liabilities. Note that our approach differs from the usual measurement of bank activities that are built on the amount of credit extended to the private sector or the ratio of total bank credit or total bank assets to a nation's GDP. Our measurement of liquidity creation complements the literature by also taking into account the nature of the source of funding and thereby enabling a holistic comparison of financial systems, e.g., with the U.S. evidence in Berger and Bouwman (2009).

Using the Berger-Bouwman liquidity creation measure, we document the amount of liquidity created by European banks over time. The more developed EU15 are the predominant contributors to this collective amount. The share of the Ascending EU is small but growing faster. In order to judge the importance of bank financing and to compare with the existing literature on U.S., we scale liquidity creation by GDP for the overlapping sample period between our European sample and the U.S. sample in Berger and Bouwman (2009). We find that the collective liquidity creation amount of U.S. banks[18] during the 1998-2003 period is between 25% and 29% of GDP. In our European sample the range of the ratios is between 74% and 101%, implying a much more important role of banks in the European economies[19].

Our next theoretical framework comes from the bank equity literature. We examine the role of equity capital in bank liquidity creation in light of two streams of theories that point to the opposite directions. On the one hand, Diamond and Rajan (2000, 2001) maintain that a fragile bank capital structure mainly composed with liquid deposit is essential for bank liquidity creation by forcing the bank to commit to the monitoring and collection of loans and

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[18] The liquidity creation data by U.S. banks between 1993 and 2003 can be found in the website of Christa Bouwman.

[19] In the existing literature (see, e.g., Allen et al 2006), bank loans are shown to be around 110% of GDP in EU and 60% in U.S. By overlooking the liability side of bank balance sheet and the liquidity nature of all balance sheet items, these percentages overstate the importance of bank liquidity creation in the mentioned regions and underestimate the gap between EU and US in the importance of bank financing.

passing on the gains to the depositors. Equity capital that reduces fragility would reduce the commitment of banks towards depositors and hence their ability to create liquidity. Gorton and Winton (1995) suggest that illiquid equity capital could crowd out liquid deposits and thereby make the liability side of the banking sector balance sheet less liquid. In other words, a less liquid composition of bank liability part hinders bank liquidity creation. On the other hand, equity capital may be beneficial to bank liquidity creation due to its ability to absorb risks. Diamond (1984) and Froot and Stein (1998) suggest that banks must hold some equity capital of its own to weather the unexpected losses given rise by idiosyncratic risks such as credit risks. Since banks create liquidity when financing risky and illiquid loans, i.e., loans with high level of idiosyncratic risks, holding higher level of equity capital becomes essential for banks in liquidity creation. More capital, in this line of reasoning, could enhance liquidity creation. However, we also recognize that the general attitude of European government towards their banks is more protective. It is a strong belief in Europe that governments will not allow banks to fail and depositors to suffer losses (Benink and Benston (2005)). The government protection, implicit or explicit, can be a substitute for equity in risk absorption. In other words, banks are better off holding less equity capital given a stronger government guarantee. As a consequence, the role of equity in risk absorption and in facilitating liquidity creation could be curtailed. Overall, the theoretical prediction of the role of equity capital in bank liquidity creation in Europe suggests a negative relationship.

Consistent with our hypothesis, we found that equity has a significantly negative relationship with bank liquidity creation for all European banks with the only exception of large banks in Ascending EU where the negative relationship is insignificant. Based on these findings, particularly the finding that the role of equity is also strongly negative for the liquidity creation by small banks which have less opportunity to reduce risks by diversification or hedging and hence should benefit from equity capital in risk absorption, we argue that government guarantee dominantly substitutes the risk absorption role of equity in Europe. Given such an institutional context, the imposition of capital regulation such as the minimum capital requirement in the (revised) Basel II framework is likely to adversely affect bank liquidity creation in Europe.

Third, the competition literature is also crucial to the examination of European banking sector. Since the adoption of the Second Banking Directive in 1995, European banks are allowed to operate in other EU countries by setting up branches or directly offering a wide range of banking services. In order to know the effectiveness of the Second Banking Directive, it is of significant policy relevance to examine how the market share of individual banks and the competitive landscape of a banking sector affect liquidity creation. The existing competition literature provides contradictory predictions for the relationship between competition, market power and liquidity creation. On the one hand, Petersen and Rajan (1995) suggest that high level of market concentration makes it more likely that small and risky borrowers can obtain bank loans because banks in more concentrated market can more easily inter-temporally smooth interest charges on the loans. On the other hand, the structure-conduct-performance theory in banking suggest that market power is likely to adversely affect bank liquidity creation because banks in a less competitive environment are less likely to adapt their service range and price structure to the needs of their customers and thereby reducing the demand of banking services (see e.g., Berger and Hannan (1989, 1991) and Hannan (1991)).

We find that the market shares of individual banks have significantly positive relationship with liquidity creation, except for small banks in Ascending EU. Market concentration is beneficial to liquidity creation by small banks in EU15 but is detrimental to liquidity creation by large banks in Ascending EU. These results suggest that controlling the overall level competition, banks with stronger market power create more liquidity, therefore consistent with Petersen and Rajan (1995). In the meantime, depending on the institutional context and the size of the banks, the level of market concentration formed by all banks in the market also affects liquidity creation by individual banks. We further investigate the impact of institutional context on liquidity creation next.

The central messages from the first half of the paper include that holding more equity capital reduces bank liquidity creation, larger market share enhances liquidity creation, and market concentration may or may not affect liquidity creation depending on the region and bank size. Some of these results, particularly the last one, suggest that institutional context may also affect liquidity creation. More specifically, the diversity of the European countries may raise the question whether our findings are due to the true impact of the level of concentration of country's banking sector, not due to other institutional factors. The second half of the paper addresses two alternative explanations. First, we examine the different levels of creditor protection amount EU countries. In our sample of European countries, EU15 countries typically have stronger creditor protections than Ascending EU and small banks are more inclined to operate in countries scored higher in creditor protection. Since the credit protection we use measure the rights that lenders have against the borrowers in such event as default or breach of contract covenants, it has conceivable implications on bank liquidity creation. The existing literature typically found that banks operating in countries with stronger creditor rights issue more loans than in countries with weaker creditor rights (Djankov et al

2007). We extend this relationship to our study of liquidity creation and, more importantly, to the joined impact of creditor rights and market concentration on liquidity creation. The inclusion of the interaction between creditor rights and market concentration is motivated by the consideration that the power brought to banks by greater level of market concentration may depends on the protection the banks enjoy in disputes with borrowers. In countries with poor creditor protection, banks may not be able to successfully exercise contractual terms despite the market power they have brought by high concentration.

We found that in EU15, the interaction between creditor rights and market concentration has significantly positive impact on liquidity creation. The interaction term however is significantly negative in Ascending EU for the liquidity creation by small banks. This is consistent with the finding that stronger creditor protection in developing countries may create inefficiency and injustice (Djankov et al (2003)), which, in our context, may reduce liquidity creation. Small banks in Ascending EU may be particularly prone to such inefficiency and injustice because unlike the large banks in their country they lack economic or political cloud.

Next, we examine if our results are driven by bank ownership. Banks that have foreign operations may have more opportunity to diversify their portfolios among a wider customer base, which in turn may reduce risks and improve liquidity creation. However, foreign banks may not have as much knowledge about the local market and customers as the domestic competitors, which may force them to rely on standardized and liquid loans instead of relationship lending and in turn reduce liquidity creation.

All our previous results regarding market concentration and creditor rights as well as their interaction generally remain robust to the inclusion of foreign ownership. Our results on ownership show that foreign banks operating in the Ascending EU, large and small, create more liquidity. Small foreign banks that operate in EU15 however create less liquidity. However, the significantly negative sign of the interaction term between foreign ownership and market share for large banks in Ascending EU signals that large foreign banks with large market share in the local market in Ascending EU create less liquidity. These results suggest that foreign banks that operate in the less developed banking market of the Ascending EU have advantages over the local competitors in liquidity creation. However, in the more developed EU15 banking market, small foreign banks are less capable than their local competitors in creating liquidities. In the meantime, if large foreign banks operating in Ascending EU also have large market share, they would reduce the liquidity position in the economy. These results may also imply that the effect of the Second Banking directive that intends to improve Europe-wide competition in the banking sector may be asymmetric and more beneficial to Ascending EU because the presence of foreign banks improves the liquidity position of their economy.

The rest of the paper is organized as follows. Section 4.2 briefly describes a few key features of the European banking sector. Section 4.3 lays down the theoretical framework. We describe our data sources, data collection criteria and methods, and the features of our datasets in the next section. Section 4.5 reports and analyzes the baseline regression results. Section 4.6 explores potential alternative explanations. The final section concludes the paper.

## 4.2 The European banking market

In this section we briefly discuss three key features of the European banking market that are relevant for this paper.[20] First, European governments have traditionally played crucial role in the maintenance of financial stability, the rescue of endangered bank, and even the operation of banks. For example, during the Nordic banking crisis, both the Swedish and Finnish governments took control of the troubled banks (Drees and Pazarbasioglu 1995). French government provided extensive assistance to Crédit Lyonnais in the 1990s during its financial trouble and the subsequent restructuring (Coleman 2001). As a result of the precedence of government interventions and also the more socialist ideology, the common perception in Europe is that the governments will not allow banks to fail so that depositors would not suffer losses (Benink and Benston 2005). There could be two consequences to such an ideology. On the one hand, banks may undertake risky investments or reduce their capital holding to take advantage of the government guarantee. Hence equity capital would become an even more expensive source of financing due to its reduced necessity. In the meantime, depositors, knowing that they will be bailed out by the government if banks fail, would not have incentives to monitoring their banks. In addition, depositors feeling more secure about their deposits may opt for more illiquid type of deposit accounts such as time deposits rather than demand deposits because they do not require the ability to withdraw quickly during crisis. Both consequences may have implications on bank liquidity creation.

Second, the dominance by large banks in the European banking sector is more severe than in US. As will be shown later, the amount of liquidity created by large banks (banks with

[20] Here it is sufficient to depict the general picture of the European banking market. A more detailed, country-level description is beyond the scope of this paper. Allen et al (2006) provides an excellent survey in this regard.

above € 1 billion total assets) is 20 to 30 times the amount created by small banks. In the US sample in Berger and Bouwman (2009), the difference is less than 10 times. Larger banks are more capable of diversify risks among a wider product range and a broader customer base, which may improve their ability to creating more liquidity. Larger banks may also enjoy stronger market power brought by bigger market share and higher degree of market concentration. As we will review in the next section, both market share and market concentration may improve or obstruct liquidity creation. The different characteristics of large and small banks also make it necessary to investigate them separately.

Finally, the EU is composed with countries of great varieties. We make the distinction between a more developed group composed with EU15 (also including Switzerland), and a less developed group consisting of the 10 newly admitted Ascending EU countries. The first group is characterized by stronger economies, longer history of institutional establishment, and also longer history of regulation adaptation such as the Second Banking Directive, etc. Many of the Ascending EU countries are ex-communist sovereigns with underdeveloped social and financial institutions. As we will later show that the EU15 countries have more powerful banks in the sense that most liquidity in Europe is created by banks in this group of countries. The separate treatment of these two groups of countries is necessary to disentangle the possible impact of economic and institutional environment on bank liquidity creation.

### 4.3 Theoretical frameworks

In this section we discuss the theories relevant to our examination of the European banking market. In particular, four schools of thoughts are closely related to our study of bank liquidity creation in a market as diversified as the European Union. The first is the quantification of liquidity creation. The second stream of theories relates to market competition and an individual bank's market power and their effects on liquidity creation. The third is the effect of bank equity capital on liquidity creation and how this effect may differ in different institutional contexts. Finally, we review the literature on the possible interaction between institutional conditions of a country and banking sector competition and the effect of this interaction on bank liquidity creation.

#### 4.3.1 Quantification of liquidity creation

The theory of financial intermediation suggests that banks create liquidity by transforming liquid liabilities such as demand deposits into illiquid investment such as loans to enterprises (see e.g., Diamond 1984, Ramakrishnan and Thakor 1984, and Boyd and Prescott 1986). Therefore, when quantifying the amount of bank liquidity creation, Berger and Bouwman (2009) suggest that the liquidity characteristics of all bank balance sheet items, assets and liabilities alike, needs to be appropriately accounted for. The Appendix to this chapter gives more details on the liquidity creation measurement we adopt from Berger and Bouwman (2009). In particular, we classify all bank balance items into three classes, liquid, semi-liquid, and illiquid, based on how easily they can be converted into cash at fair value. Examples of liquid assets include cash and government bills; a prominent example of liquid liability is demand deposits. Illiquid assets may be loans to corporations, and illiquid liabilities may be subordinated debt and bank equity. Banks only create liquidity when they finance illiquid assets with liquid liabilities. In other words, the determination of the success of European banks in liquidity creation should take into account both the assets side and liability side of their balance sheets.

If European banks indeed are the main source of funding for companies as suggested by Allen and Gale (2000) and Allen et al (2006), it then may be the case that these banks have more illiquid and risky loans on the asset side of their balance sheets. In the meantime, European governments have traditionally been more protective of their banks in the sense that it is a widely held belief that European governments will not let their banks fail and their citizens suffer losses due to bank failure (Benink and Benston 2005). European governments have also orchestrated many rescues of their ailing banks[21]. In such a regulatory environment, the source of financing of European banks may also be more illiquid than their U.S. counterparts since depositors do not require as much ability to withdraw their deposits in distress, i.e., to run on their banks. Therefore, the comparison of European banks with their U.S. counterparts in liquidity creation after taking into consideration both bank's assets and source of funding depends on whether illiquid investments outweigh illiquid liabilities. Note that our approach differs from the usual measurement of bank activities. In the existing literature, the effectiveness of bank liquidity creation is mainly measured by the amount of credit extended by the banking sector to the private sector. The comparison of financial systems also normally uses the ratio of total bank credit or total bank assets to a nation's GDP. Our liquidity creation measure complements the existing one by also taking into account the

[21] See, e.g., Drees and Pazarbasioglu (1995) for reviews of the Nodic bank rescue, and Coleman (2001) for the assistance given by the French government to Crédit Lyonnais.

nature of the source of funding and thereby moving one step further in establishing a holistic comparison of financial systems that also considers the liability side of bank balance sheet.

### 4.3.2 Market power, market concentration, and liquidity creation

Since the formation of the European Union, Europe-wide legislations have been adopted to foster a more competitive common European market that allows member states as much freedom in other member states as in the domestic market. One example of such legislation is the Second Banking Directive adopted by EU countries in 1995. Under this directive, European banks are allowed to operate in other EU countries by setting up branches or directly offering a wide range of banking services. In addition, several major European countries have gone through extensive reform of their banking industry under the premise of enhancing competition and improving banking efficiency[22].

The existing literature however provides contrasting theoretical as well as empirical grounds regarding the role of competition and market power in banking efficiency. On the one hand, Petersen and Rajan (1995) suggest that market concentration helps improve bank liquidity creation by allowing the banks to retain customers and inter-temporally compensate the initial cost incurred in gaining the customers with the profit obtained at a later stage when the customers are locked in[23]. Petersen and Rajan also show that being more capable of locking in customers over longer period of time in such a market environment, banks are more likely to issue loans to small and risky borrowers. Therefore, banks create more liquidity in more concentrated market where the likelihood of movements of borrowers between banks is reduced. Bharath et al (2007) further show that banks with larger market share are more likely to be chosen by the borrowers for future loans and other information-sensitive banking business.

On the other hand, the structure-conduct-performance theory in banking (see, e.g., Berger and Hannan, 1989) suggest that high concentration is likely to adversely affect bank liquidity creation because banks in a less competitive environment are less likely to adapt their service range and price structure to the needs of their customers and thereby increasing their own profitability but possibly reducing the attractiveness of banking services, which in turn

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22 See, e.g., Bertrand, Schoar and Thesmar (2007) for a review and analysis of the French banking reform, and Perez (2001) for Spanish banking reform.

23 Berlin and Mester (1999) also show that banks are able to smooth out loan pricing over multiple loans in relationship lending. Sharpe (1990) and Rajan (1992) suggest that market power allows banks to charge excessive interest rates on borrowers for loans.

reduces bank liquidity creation. Hannan (1991) further suggests that interest rate charges on loans increase with market share and market concentration, implying higher prices for borrowers and lower demand for bank loans.

Meanwhile, Hannan and Berger (1991) and Hannan (1991) show that high level of market concentration makes it less likely that banks would increase deposit rates while larger market share results in stronger likelihood that banks would decrease deposit rates. These results suggest that on the liability side of bank balance sheet weaker competition in the banking sector and stronger market power of individual banks may reduce the attractiveness of bank deposits. From the perspective liquidity creation, the impact of the price rigidity of deposit rate depends on if and where the depositors transfer their deposits after the bank reduces deposit rates. If depositors react to the adverse movement of deposit rates by transferring funds from time deposits to demand deposits, for example, to become ready to transfer the funds again to places with higher returns, then the liquidity creation measurement of the bank would be improved (albeit temporarily) because the bank now has more liquid composition of funding. If however, depositors stick to their original deposits despite the lower interest rates or they switch to bank equity, price rigidity on deposits will not reduce liquidity creation or even improve it because the liability side of bank balance sheet becomes more illiquid.

We investigate the relevance of the existing theories in European banking sectors by including in our regressions both the degree of market concentration and the market share of individual banks. If stronger market power benefits liquidity creation, as in Petersen and Rajan (1995) and Bharath et al (2007), we would expect positive relationships between market share, market concentration and liquidity creation. If the structure-conduct-performance hypothesis dominates, stronger (weaker) market share and high (low) market concentration would both reduce (improve) liquidity creation. In addition to the examination of the impact of market share and market concentration on the collective liquidity creation measure, we also separately look at the asset and liability components of the liquidity creation measure. While the structure-conduct-performance hypothesis suggests the potential negative impact on both the borrowers and the depositors, it is not entirely clear how the positive effect on borrowers suggested by Petersen and Rajan (1995) above would affect depositors. By separately examining the asset and liability components of the liquidity creation measure, we can tell if the impact of market power and market concentration on liquidity creation is through assets or liability, or both channels.

### 4.3.3 Bank equity capital and liquidity creation

There are two major schools of theories regarding bank equity capital and liquidity creation. Following Berger and Bouwman (2009) we call the first school the “fragility-crowding out” theory, which suggests a negative relationship between equity capital and liquidity creation, and the second “risk-absorption” theory, which suggests a positive relationship. Specifically, in Diamond and Rajan (2000, 2001) the role of a bank is to represent a group of depositors and collectively channeling funds, in the form of deposits, to companies with positive NPV projects that need funding, and then monitoring the borrowers and collecting the loans. In this process, the bank, in its constant interaction with the borrower, can acquire private information on the nature of the borrower’s business and the quality or creditworthiness of the borrower. This information gives the bank an advantage over depositors in assessing the profitability and future viability of the borrower. This information advantage however gives rises to an agency problem. The bank has the incentive to increase its own profitability at the cost of the depositors by asking a bigger share of the interest income and thereby threatening to withhold monitoring or loan collecting effort. Knowing such a possibility, the depositors would be reluctant to entrust their deposits with the bank in fear of the bank abusing their funds and trust at a later stage. Knowing the potential actions by the depositors if the bank withholds effort, the bank will commit to the depositors in the first place by having a fragile capital structure that mainly consists of liquid deposits so that the bank would risk losing all funding if it attempts to withhold depositors. Equity capital reduces the fragility of bank capital structure and increases the bargaining power of the bank and therefore reduces the credibility of its commitment to the depositors. Knowing the reduced commitment, the depositors would not provide as much funding to the bank. The liquidity creation function of banks therefore is reduced by equity capital.

Gorton and Winton (2000) suggest that in the whole economy there is a fixed total amount of deposit plus equity capital at any time. The increased equity capital must come from reduced deposit. In other words, equity capital can only grow by “eating into” deposits. In the process of crowding-out, the liquidity position of the whole economy decreases because there is more illiquid equity capital and less liquid deposit. Therefore, the financial fragility and crowding-out theories both suggest that equity capital has negative impact on liquidity creation.

On the other hand, Diamond (1984) and Froot and Stein (1998) suggest that the role of bank equity capital is to mitigate risks that cannot be diversified. Specifically, banks, in collecting deposits and channeling these deposits to entrepreneurs who need the fund for risky investments, face two categories of risks, systematic risk such as interest rate risk or exchange risk, and idiosyncratic risk such as credit risk. The key distinction between these two risk categories is that the former is well understood by the financial market and can easily be transferred away with such financial instruments as forward or future contracts, which are accessible at fair prices due to the many market participants that deal with them. The idiosyncratic type of risks however cannot be convincingly communicated to the general market. For example, the risk of a borrower to default or be downgraded, i.e., credit risk, can only be learned by banks in their regular interactions with the borrower over certain period of time. This knowledge is private to the bank in the sense that other market participants cannot know the true nature of the borrower without an established relationship and long-term interaction with the borrower. In other words, if the bank decides to share with other market participants their knowledge about a borrower, there is no way for others to verify the shared knowledge at little costs. Therefore, the idiosyncratic type of risks cannot be easily hedged in the financial markets and there are few standard financial instruments that a bank can buy to reduce credit risk exposure at fair prices[24]. In order to mitigate these risks, a bank must hold some equity capital of its own.

Therefore, there is a direct relationship between bank equity capital and its ability to issue loans that have idiosyncratic risk components. The more equity capital a bank has, the more risky loans it would be able to issue. The reverse is also true. The more idiosyncratically risky loans a bank has, the more equity capital it has to hold. In this line of reasoning, there should be a positive relationship between bank equity capital and liquidity creation.

However, equity capital is necessary when there is a need for banks to meet financial obligations in time of unexpected losses. If the banks have other fallbacks to rely on for absorbing the losses, the role equity capital would be diminished. In Europe, as suggested by Benink and Benston (2005), stronger government guarantees, explicit or implicit, can be considered substitute for equity capital. Benink and Benston also observe that banks in EU have traditionally held much less capital than their U.S. counterparts. Therefore, taking all theories together, we expect that the relationship between equity capital and liquidity creation is negative in Europe.

[24] Even though there has been a rapid growth in the credit derivative market, most standardized credit derivative products are only for the very large public companies for which analyst coverage is abundant. Other credit derivatives are mostly over-the-counter custom made contracts that are established case-by-case.

### 4.3.4 Institutional context and bank liquidity creation

Even though we try to disentangle the impact of institutional context on liquidity creation by running regressions separately for different bank size and country groups, there may be other factors that pollute the results. In particular, banks that operate in countries with stronger creditor protections are shown to issue more loans (Djankov et al 2007). The strength of a country's creditor rights is important to bank credit because banks may become reluctant to issue risky or illiquid loans when they expect difficulties in settling dispute or default. This reluctance may come in the shape of higher interest charge on or direct refusal of applications for risky loans, which would reduce liquidity creation. Accordingly, in our investigation of bank liquidity creation, we add creditor rights and legal origin to our baseline models to see if these institutional factors offer additional explanatory power.

Moreover, the inclusion of creditor rights is also helpful to ascertain that our results for the relationship between market power, market concentration and liquidity creation is not due to the influence of creditor rights. It is conceivable that banks operating in countries with weak creditor protection have to have high concentration so that the possibly higher legal costs in contract enforcement can be averaged out among broader customer base and wider product range brought by collective market strength. In this situation, the combination of higher market concentration and lower creditor rights may facilitate liquidity creation. Equally likely is the tendency that higher market concentration is formed in countries with stronger creditor rights. Stronger market position may only translate into profitability when the creditors are protected against the losses brought by the harmful behavior of the borrowers. If the creditors know that they cannot recoup their lending smoothly from default borrowers or borrowers that breach contracts, they may be unwilling to expand their market position to include more relatively high-risk businesses in the first place, which in turn reduces the likelihood of high market concentration and more liquidity creations. While it is beyond the scope of this paper to address the causality between creditor rights and market concentration, the above conjectures mean that there may be some interactions between the two. Therefore, we will also include the interaction term between creditor rights and market concentration in our model and it seems to be an empirical question how creditor rights interact with market concentration in liquidity creation.

Additionally, the interaction between creditor rights and market concentration may have different impact on liquidity creation depending on the types of countries. Djankov et al (2003) suggest that stronger creditor rights in developing countries may create inefficiencies and injustice. The reason is while the variable used to proxy creditor rights mostly measures the existence of certain legislatures that specify the legal rights of the creditors, it does not measure how easily the legislatures can be enforced (see Djankov et al 2007). In developing countries, the legal infrastructure may be less efficient in realizing the more complete set of creditor protection program and may therefore render the legal proceedings more cumbersome and costly to follow through. Therefore, in the developing Ascending EU countries, it is likely that high market concentration and stronger creditor rights can reduce liquidity creation because the banks with larger market shares may more often have to deal with the cumbersome legal procedures, which cost bank resources and hamper liquidity creations.

### 4.4 Data

To construct a dataset that has detailed balance sheet items for all banks, we started with the February 2008 version of Bankscope data downloaded from Wharton Research Data Service (WRDS) for all 25 EU countries plus Switzerland. Bankscope data can be accessed either directly via a browser based interface or WRDS. The advantage of the former is that the data may be more up-to-date, while the later access provides more data format and is much easier to download. However, WRDS may not be synchronized with Bankscope and has less up-to-date data. After downloading the data, we find in the early 2008 version, observations for 2006 are only very sparsely populated. For some countries, the year 2005 also cannot be considered consistently populated. Take Germany, the largest economy in Europe, as an example. In year 2004, Bankscope has 1376 banks for Germany but in 2005 the number dropped to 608. All other aggregate banking asset items also dropped dramatically. This is unlikely to be the realistic pattern but may be due to the delay in database construction. (We confirmed with Bureau van Dijk, the owner of Bankscope, that there is indeed a considerable time lag between the browser-based access to Bankscope and the WRDS). Similar inconsistencies exist in many countries in the data. In particular, the data before 1998 and after 2004 appear to be very different from the period during the period in terms of number of banks. Therefore, we keep the data for the period from 1998 to 2004 to maintain the consistency of the sample coverage.

Next, we address the duplication issue in the downloaded Bankscope data. For some banks, the original Bankscope data has duplicated entries in four ways. First, both the consolidated and unconsolidated balance sheet data are included for banking groups and/or banks operating in multiple countries. We keep only the unconsolidated data because we need to measure the amount of liquidity creation and the level of competition within the countries' banking industry. Therefore, the overseas operations of multinational banks cannot be included, and the consolidated balance sheets that include the operations of the subsidiaries of the banking groups are not suitable. The use of unconsolidated balance sheet entries that separately account for subsidiaries and country-level units is appropriate. Second, banks that merged with or acquired other banks are duplicated in Bankscope prior to the combination. For example, if A and B merged, Bankscope may include A, B and the pro forma combined new company prior to the actual merger. After the merge, only the resulting new bank exists. We delete the pro forma entries from our database. Third, the insurance subsidiary of some Bankassurance companies, such as Fortis and ING, are also listed in Bankscope. We delete these entries to focus only on banking operations. Finally, in 2003[25] the European Commission demanded the adoption of the International Financial Reporting Standards (IFRS). Bankscope data reflects this regulatory change by listing both the balance sheet data under IFRS and under the original accounting standards (primarily the national GAAP) for some bank/countries. This duplication is particularly prevalent in year 2004 and in the new EU countries. It also happens that the duplication is present for some banks for the entire sample periods. As a solution, we delete all duplicated entries according to the following principle. If the duplication exists for the entire sample period, we keep the entries under IFRS; if only in a limited number of years are there duplicated entries under IFRS, we keep the entries under the original accounting standards consistent with the rest of the sample period. In our later econometric models, we will take into account the difference in accounting standards.

### 4.4.1 Construction of the bank-level balance sheet data

As can be seen in the earlier sections, our liquidity creation measures require very detailed bank level balance sheet data. Unfortunately the level of detail provided by Bankscope data is insufficient for most countries/years. In particular, the deposit items are almost always incorrectly aggregated into the item Other Deposits (DATA6030) while in reality, the deposits are spread over such items as demand deposits, savings deposits, time deposits, etc.. Since deposits are the major source of financing for most banks and the correct classification of them is crucial to correctly construct our liquidity creation measure. The original Bankscope

[25] See European Commission Regulation (EC) No 1725/2003(2) and its subsequent amendments.

data cannot be directly used in its raw form.

We solve this lack of detail by complementing the Bankscope data with manually collected bank balance sheet data from the annual reports. We assembled detailed balance sheet data from the audited annual reports for some of the largest banks in each country. The number of banks on which we collected data depends on the number of banks and the level of banking asset concentration in that country's banking sector. For countries such as UK where there are more even distribution of banks among different size classes, we manually collected data for more banks, six banks in the case of UK. For other countries, such as Switzerland, where large banks predominate, we manually collected data for fewer banks, two banks in the case of Switzerland. However, six is the maximum number of banks we manually collected data for in all countries, and two the minimum.

In collecting data from the annual reports, a further challenge is to find the values of the balance sheet items of banks operating in multiple countries at the domestic country level. This is because we need to measure the level of concentration and competition for a country's banking sector. Counting in multinational banks' operations in foreign countries will distort the competitive landscape of the domestic banking sector, and also overstate the amount of liquidity created by these banks in their resident countries. The balance sheets of our chosen banks offer various degrees of disclosure regarding their operations at the country-level. These different degrees of disclosure and our method of tackling with them can be grouped into the following situations:

Situation A: if the banks disclose detailed country-level balance sheet/income statement information, we just use them.

Situation B: banks may disclose only their country-level distribution of total assets. We then use the ratio of country-level total assets to consolidated total assets to calculate other items of the balance sheet. Specifically, we multiply the ratio of country-level assets to consolidated total assets by all other consolidated balance sheet items to arrive at the country-level figures of these items.

Situation C: Banks may disclose only their country-level distribution of total income/revenue. We then use the ratio of country-level total income to consolidated total income to deduce all items of the balance sheet.

Situation D: Some banks disclose the distribution the number of employees and/or branches they have at the country-level. If none of situations A to C above turns out to be true, we use the ratio of the number of employees/branches in a country to the total number of employees/branches to calculate the amount of all balance sheet items in that country.

Situation B to D may be present at the same time, or, in other words, banks that do not disclose all of their country-level balance sheet items may disclose more than one of the following items: country-level assets, country-level income, and/or distribution of overseas employees/branches. If more than one of these quantities are available, we calculate the average of these available ratios to arrive at the final ratios to be used for producing the whole balance sheet. Note however that in most cases, these different ratios are reasonably close to each other, with differences within 5%.

In all the above four situations, it also sometime is the case that the country-level disclosures are available for less than the whole sample period. In that case, we will use the average of the ratios of the available years to fill in the missing years.

With these methods, we gathered country level balance sheet data for 101 banks for the 26 countries in our sample. Then we integrate these manually collected data in different ways into the downloaded Bankscope data to compile two sets of data that we will use for the main analyses and the robustness check. These datasets are:

Data set 1: Main data set:

Component 1: data for the hand-collected 101 banks;
Component 2: original BankScope data for other banks, adjusting only the deposits items if necessary[26].

Data set 2: Robustness check data set:

The original BankScope data for all banks, adjusting only the deposits items if necessary[26].

Additionally, in the above two data sets there are about 500 observations that have total off-balance sheet items higher than total assets in value. 75% of these observations belong to

[26] In some countries such as Belgium the original Bankscope is already detailed enough for the deposit items. In these countries we do not adjust for deposit items.

small banks, i.e., banks with less than € 1 billion total assets, and none of these observations come from the banks for which we manually collected data. Since it is well-known that small banks are much less active in the use off-balance sheet products and very unlikely to have such large exposures to them, we treat the OBS items of these observations as outliers and replace them with the average of the rest of the national sample. However, the regression results without these adjustments remain qualitatively the same.

### 4.4.2 Adjusting for country and year differences

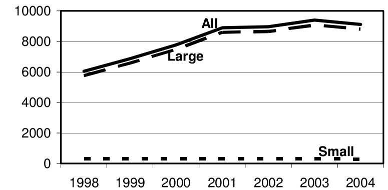
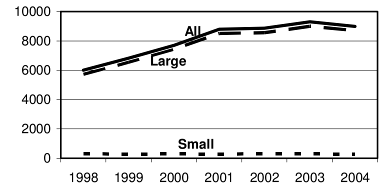
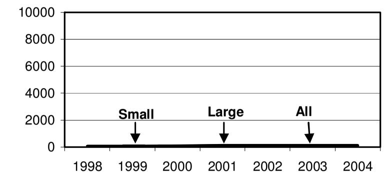
The balance sheet items manually collected from the annual reports and those coming from Bankscope have different units and currency of denomination. The real values of these figures also differ across the sample period due to inflations. In order to make these figures comparable across all countries and years, we convert them into billions of euro using nominal exchange rates collected from the European Central Bank or national central banks. We then adjust for inflation using the GDP deflators collected from the World Bank for each country and year.

### 4.4.3 Summary statistics

Table I below presents the amount of liquidity creation, measured by our Cat Fat measure, of the 26 countries in the sample in 1998 and 2004, and the pattern of development over time. Table II presents the summary statistics of all other variables. We split our sample into large banks (TA above € 1 billion) and small banks (TA below € 1 billion). In 1998, the three countries whose banking sectors create the most liquidity on balance sheet are, in descending order, UK, France and Germany. In 2004, the banking sectors in these three countries still create the most liquidity, but the order changed to France, UK and Germany. Like the US banks in Berger and Bouwman (2009), large banks are the predominant liquidity creators in Europe as well, except for the new EU countries where large banks rarely exists, and small banks play more important roles, which can sometimes collectively create more liquidity than large banks. In terms of quantity, the new EU countries fall far behind the more developed ones in liquidity creation. In year 2004, all 10 new EU countries collectively create € 123 billion, a mere 1.4% of all liquidity created by the 28 countries in that year. In earlier years, that ratio is even lower, at around 0.8%.

## Table I
## Summary statistics on bank liquidity creation

This table shows the summary statistics of bank liquidity creation Europe in 1998 and 2004, the beginning and ending year of the sample, respectively. The graphs to the right show the time series pattern of the liquidity creation over the entire sample period. The statistics are separately shown for all banks, large banks (total assets above € 1 billion), and small banks (total assets up to € 1 billion) in the whole sample, the sample of EU15+Switzerland, and the sample of Ascending EU. N is the number of banks, LC is the amount of liquidity creation measured by Cat Fat described in Appendix, TA is total assets, EQ is total equity, LNS is total loans, DEP is total deposits.

| | | 1998 liquidity creation | | | | | | 2004 liquidity creation | | | | | | Liquidity creation: Sample periods |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | LC | LC / TA | LC / EQ | LC / LNS | LC / DEP | N | LC | LC / TA | LC / EQ | LC / LNS | LC / DEP | Billion Euros |
| All Countries | All | 4038 | 6051 | 0.37 | 7.61 | 0.65 | 0.58 | 3698 | 9110 | 0.34 | 6.86 | 0.58 | 0.61 |   |
| | Large | 1133 | 5746 | 0.37 | 7.86 | 0.65 | 0.58 | 1320 | 8817 | 0.34 | 7.01 | 0.58 | 0.61 | |
| | Small | 2905 | 305 | 0.36 | 4.76 | 0.64 | 0.52 | 2378 | 293 | 0.37 | 4.09 | 0.58 | 0.60 | |
| EU15 and Switzerland | All | 3911 | 6004 | 0.37 | 7.64 | 0.65 | 0.58 | 3461 | 8987 | 0.34 | 6.96 | 0.60 | 0.61 |   |
| | Large | 1105 | 5709 | 0.37 | 7.88 | 0.65 | 0.58 | 1241 | 8714 | 0.34 | 7.11 | 0.59 | 0.62 | |
| | Small | 2806 | 295 | 0.36 | 4.81 | 0.65 | 0.53 | 2220 | 273 | 0.37 | 4.12 | 0.61 | 0.61 | |
| Ascending EU | All | 127 | 47 | 0.36 | 4.86 | 0.40 | 0.45 | 237 | 123 | 0.31 | 3.34 | 0.17 | 0.41 |   |
| | Large | 28 | 37 | 0.36 | 5.31 | 0.38 | 0.44 | 79 | 103 | 0.30 | 3.28 | 0.15 | 0.40 | |
| | Small | 99 | 11 | 0.37 | 3.77 | 0.50 | 0.45 | 158 | 21 | 0.39 | 3.68 | 0.34 | 0.52 | |

## Table II: Definitions and summary statistics for explanatory variables

| Variable | Definition | Large banks: Mean for all large banks | Large banks: Mean for EU15 + Switerland | Large banks: Mean for Ascending EU | Small banks: Mean for all small banks | Small banks: Mean for EU15 + Switerland | Small banks: Mean for Ascending EU |
|---|---|---|---|---|---|---|---|
| | **Core variables** | | | | | | |
| ***Bank equity capital ratio*** | | | | | | | |
| CapRatio | Total equity capital as a percentage of total assets | 6.76 | 6.67 | 8.88 | 10.14 | 10.00 | 13.13 |
| ***Competition measure*** | | | | | | | |
| Market Concentration | Country-level Herfindahl index based on the catfat liquidity creation measure of all sample banks, in percentage. | 7.92 | 7.56 | 16.91 | 8.75 | 8.38 | 16.84 |
| Market Power | Bank-level market share of the catfat liquidity creation measure in its country in a year, in percentage | 1.67 | 1.23 | 12.75 | 0.13 | 0.02 | 2.47 |
| | **Control Variables** | | | | | | |
| ***Bank specific variables*** | | | | | | | |
| Ln(TA) | Natural log of total assets | 22.18 | 22.20 | 21.82 | 19.12 | 19.13 | 18.77 |
| Credit risk | Problem loans as a percentage of total assets, in percentage | 2.29 | 2.14 | 6.00 | 2.68 | 2.56 | 5.39 |
| Accounting | A dummy that equal 1 if the bank/year observation uses IFRS accouting rules. | 0.03 | 0.02 | 0.51 | 0.02 | 0.00 | 0.47 |
| ***Macroeconomic Environment*** | | | | | | | |
| Deposit insurance | Ratio of deposit insurance coverage amount to per capita deposit amount. Source: World Bank | 261.26 | 251.05 | 520.24 | 298.37 | 285.54 | 577.62 |
| Ln(POP) | Natural log of country-level population | 17.35 | 17.41 | 15.85 | 17.43 | 17.51 | 15.68 |
| POP growth | Annual country-level population growth rate, in percentage | 0.38 | 0.40 | 0.00 | 0.25 | 0.27 | -0.21 |
| POP density | Population density measured by the population per square kilometers from United Nations Population Division (UNPD) | 180 | 183 | 106 | 191 | 196 | 93 |
| Working age percent | Percentage of peopole aged 15-64 years old, from UNPD | 67.19 | 67.15 | 68.22 | 67.64 | 67.64 | 67.82 |
| FDI | Annual foreign direct investment as a percentage of GDP from World Bank. | 9.97 | 10.14 | 5.54 | 5.34 | 5.34 | 5.33 |
| Creditor rights | An index aggregating creditor rights. The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed. Source and details: Djankov et al (2007). | 2.14 | 2.15 | 1.87 | 2.40 | 2.41 | 1.98 |
| Legal origin | A dummy variable that identifies the legal origin of the Company law or Commercial Code of each country. The four origins present in our sample countries are English, French, German, and Nordic. Source: Djankov et al (2007). | Number of countries that belong to English, French, German and Nordic legal origin are, respectively: 3, 9, 10, 3. | | | | | |
| Mkt-cap ratio | Percentage of stock market capitalization to GDP from World Bank | 76.83 | 78.99 | 21.99 | 73.72 | 76.30 | 17.53 |

Graphs (not shown) of country-level liquidity creation over time demonstrate that the growth of liquidity creation also shows very distinct patterns among countries. While the new EU countries mostly witnessed steady growth (Czech Republic, Malta and Romania are the exceptions in this group), the more developed countries show a more diverse picture. While liquidity creation in countries such as the Netherlands and Spain grow smoothly, Germany and Switzerland see their banks create less liquidity than in history. Other countries show either a more horizontal line or a more zigzagged pattern.

## 4.5 Results

### 4.5.1 Equity capital and liquidity creation

As we discussed in the previous section, the financial fragility-deposit crowding out theories suggest that bank equity would reduce liquidity creation while the risk absorption theories suggest otherwise. We also reviewed that the institutional context of European banks where government guarantees are stronger may reduce the risk absorption role of equity. To test which of these forces dominate, we regress the Cat Fat liquidity creation measure on equity capital level, market power, and other control variables, controlling for bank and year fixed-effects. The regression is done in the whole sample and in the sub-samples of large and small banks in EU15+Switzerland and Ascending EU separately. All explanatory variables, except the dummy variables, are lagged by one year. We examined alternative model specifications by varying the number of explanatory variables included and by varying the type of fixed effects included. The results of these alternative model specifications (not tabulated) show that our main results are robust.

As can be seen in Table III, the regressions of the whole samples show that the ratio of equity capital to total assets is strongly negatively associated with liquidity creation for both large and small banks. The regressions of the sub-samples of EU15 and Ascending EU further demonstrate that the negative relationship is significantly negative in all sub-samples with the only exception for large banks in Ascending EU. The coefficients imply that for large banks in EU15 with a 1% higher in equity capital ratio create about 0.55% less liquidity of total assets. In the case of small banks, a higher equity capital ratio of 1% is associated with less liquidity creation of 4.6% (2.6%) of total assets in EU15 (Ascending EU). The negative relationship between equity capital and liquidity creation for small banks is consistent with the findings in the U.S. sample by Berger and Bouwman (2009), which suggests that the financial fragility-crowding out theories also dominates in small banks in Europe. However, for large banks, our finding of a significantly negative relationship between equity and liquidity creation contrasts with the positive relationship in U.S. (Berger and Bouwman 2009).

**Table III**
**Regression results for Bank Liquidity Creation**

This table reports the regression results for European banks using the whole sample, the sample of the developed EU15 and Switzerland, and the sample of developing or Ascending EU counties, respectively. The samples of large and small banks are treated separately. The dependent variable is the ratio of cat fat liquidity creation measure to total assets. A banks/year observation is defined as large (small) if the total assets is equal or above (below) € 1 billion. The definitions of the explanatory variables can be found in Table II. All explanatory variables used are lagged by one year. The sample is unbalanced and covers the period from 1998 to 2004. Reported t-statistics in the parenthesis are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1% level respectively.

| | Large banks | | | Small banks | | |
|---|---|---|---|---|---|---|
| | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** |
| **Cap Ratio** | -0.524*** | -0.546*** | -0.137 | -0.467*** | -0.462*** | -0.264*** |
| | (-4.034) | (-4.212) | (-0.304) | (-10.382) | (-9.330) | (-3.032) |
| **Market share** | 0.441*** | 0.574*** | 0.385** | -0.094** | 106.911*** | -0.016 |
| | (4.101) | (3.581) | (2.452) | (-2.143) | (8.507) | (-0.200) |
| **Market concentration** | -0.024 | -0.015 | -0.635*** | 0.200*** | 0.244*** | -0.249 |
| | (-0.459) | (-0.285) | (-3.080) | (9.260) | (12.383) | (-1.548) |
| **Year dummies** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Bank Fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **$R^2$** | 0.143 | 0.149 | 0.407 | 0.292 | 0.379 | 0.173 |
| **Observations** | 7049 | 6798 | 251 | 14541 | 13929 | 612 |

Such a contrast for large banks could be explained by the difference in the institutional context between Europe and U.S. banking sector. In European countries the explicit or implicit government guarantee for domestic banks is much stronger and in many occasions in history has been substantiated by concrete examples. In the Nordic banking crisis in the early 1990s, the governments of all affected countries played vital roles in the rescue and restructure of their ailing banks (Drees and Pazarbasioglu 1995). In the most recent sub-prime crisis and the ensuing global financial meltdown, countries such as the UK, Germany, and the Benelux countries have been active in preventing their home banks from bankruptcy. These strong and consistent government actions are in sheer contrast to the U.S. where there has not been consistent precedence that government will prevent financial institutions from failing. In fact, during the Savings and Loans (S&L) crisis of the 1980s, thousands of banks and S&L institutions failed. The strong government guarantees in Europe can be considered protection for depositors, a role similar to equity capital. Therefore, holding equity capital becomes less necessary and those that do are shown in our results to create less liquidity. This strong negative relationship is most likely because equity capital is a more expensive source of financing. The more equity a bank holds the higher its cost of financing would become and hence the higher the hurdle rate of return it must earn from making loans. Banks with higher hurdle rates and the resulting higher interest charges may have less willingness to lend and also drive the borrowers to borrow less or not at all, which in turn reduce liquidity creation.

The absence of a comparably strong and negative relationship between equity and liquidity creation for large banks in Ascending EU could be explained by the fact that these banks are mostly foreign owned (see Table VI). The guarantee provided by the local governments may not be relevant to these banks.

Our findings of a strong and negative relationship between bank equity and liquidity creation is particularly relevant to policy-makers in the consideration of capital regulation. During the aftermath of the subprime crisis and the ensuing global financial market meltdown, regulators such as the Bank for International Settlements actively form new regulatory paradigm aiming at strengthening bank's capital base (see, e.g., BIS 2009). Our results suggest that such regulations could be harmful for bank liquidity creation and slow down economic recovery if the government cannot convincingly show that they will not attempt to rescue banks from failure. Such an attempt is unlikely to be successful given the past consistent government intervention in banking distress.

#### 4.5.2 Results: market power and liquidity creation

In the regressions reported in Table III, the significantly positive coefficients of the market share of individual banks in the sub-sample of large banks in both EU15 and Ascending EU are consistent with Petersen and Rajan (1995). As risky loans load positively and more heavily on liquidity creation, the stronger ability of bank with high market power to grant such loans translates into a strongly positive relationship between market share and liquidity creation.

For the sub-sample of small banks, Table III shows that market share helps liquidity creation only in EU15. In Ascending EU however, the effect of market share on liquidity creation is statistically nonexistent. Such a contrast also renders the examination of the whole sub-sample of small banks, without splitting the country groups, inaccurate. In the regression of the whole sample, market share even has a significantly negative coefficient. The contrasting signs of market share suggest that the abilities of small banks to retain customers by gaining more market share and inter-temporally compensating interest income, as in Petersen and Rajan (1995), are likely to be absent in Ascending EU.

In the baseline regressions reported in Table III, we also investigate the impact of the competitive landscape of the banking market on the liquidity creation by individual banks. We calculate the Herfindahl index of the domestic banking sector every year based on the cat fat liquidity creation measurement and include this index in the model as a measurement of the degree of concentration of the banking market. Compared with the concentration measurement typically applied in the existing literature that are based on bank assets, loans, or deposits alone, our Herfindahl index based on the cat fat liquidity creation measurement should be more suitable in judging the level of competitiveness of the whole spectrum of banking activities, both loan making and deposit taking. Unlike market share of individual banks, market concentration affects all banks in the market. Hannan and Berger (1991) also suggest that both market share and market concentration are likely to affect the pricing behavior of deposits by banks.

As can be seen in Table III, market concentration is harmful for liquidity creation by large banks in Ascending EU but helps liquidity creation by small banks in EU15. These results complement the market share of the individual banks included in the regressions by controlling the competitive environment of the whole banking market. The results for large banks in Ascending EU suggest that holding the market power of individual banks constant, the more concentrated the banking market, the less liquidity the banks create. In other words, banks in a more concentrated market create less liquidity despite their market share. Such result can be seen as consistent with the prediction of the Structure-conduce-performance theory that banks in highly concentrated environment are more rigid in pricing setting or more likely to set prices that are to the disadvantage of the borrowers and/or depositors, which in turn reduces the attractiveness of banking product and liquidity creation. As to small banks in EU15, market concentrate enhances liquidity creation, which is on top of the benefit of larger market share.

### 4.5.3 Asymmetry between asset and liability

The structure-conduct-performance theory suggests that market power and market concentration have asymmetric impact on the asset and liability parts of the bank balance sheet. The benefits of larger market share such as the inter-temporal smoothing of interest charges in Petersen and Rajan (1995) may or may not be found in the liability part. To address the potential asymmetric relationship of the asset and liability parts of the liquidity creation with these competition measures, we disaggregate the Cat Fat liquidity creation measure into the asset and liability components and calculate the market share and market concentration based on these components only. Specifically, in Table IV the Asset (Liability) is the sum of all items listed in Appendix that can be classified into the asset (liability) side of the balance sheet, also weighted by 0.5, 0 or -0.5 according to their liquidity profile. Market share and Market concentration are then calculated with the new Asset (liability) component amount in a country/year.

As can be seen in Table IV, the market share of individual banks has significantly positive association with liquidity creation for both assets and liability component for all bank size and country group, further strengthening the suggestion by Petersen and Rajan (1995) but also extending their findings to the liability side of bank operations. The coefficients for market concentration and the interaction between market concentration and creditor rights are however not as uniform. For large banks, the only significant interaction is found in EU15 for the liability part. Stronger market concentration of the banking operation on the liability side coupled with stronger creditor protection in this region significantly improved the liquidity profile of the liability side of balance sheets. This finding seems to be consistent with Hannan and Berger (1991) in that market concentration tends to reduce the rate banks offer to deposits, which likely makes interesting-bearing deposits such as time-deposits (a more illiquid type of deposits) less attractive and forces depositors to move to demand deposits (a liquid type of deposits). Such an exchange between deposit types effectively improves the liquidity profile of the whole deposit type of bank financing. More strikingly, such an effect appears to be stronger in countries with better creditor protection. This finding may be explained in the same way as the negative impact of creditor rights on liquidity creation by small banks in Ascending EU. Specifically, stronger creditor protection as proxied in our regression by legal formalism may create excessive legal burdens for banks creditors in the event of bank failure. These burdens in turn increase the reluctance of investors in illiquid liabilities such as subordinated debt or bank equity and move to other more liquid liability items. The possibly counterintuitive fact that such a substitution takes place in EU15, where government protection for banks is stronger, may be explained by the tendency of government to rescue only depositors rather than equity holders of endangered banks[27]. Effectively, such a substitution also improves the liquidity profile of bank liability side of balance sheet.

For small banks, the regressions show that the interaction term is significantly positive for EU15 for both asset and liability components. The significant interaction term of the liability part can be explained in the same way as for large banks in EU15 above. The interaction term is also significantly positive for the asset part, meaning that small banks operating in highly concentrated market with stronger protection may feel more confident about investing in illiquid and risky loans, which in turn improves the liquidity profile of their asset side of balance sheet. In Ascending EU, the interaction term is significantly negative for the asset part and positive (albeit insignificant) for the liability part. As we argued before, in light of the suggestions by Djankov et al (2003) that better creditor protection in developing countries may result in inefficiency and injustice, banks investments in illiquid assets could be hampered by the potentially cumbersome and unfair legal proceedings. Coupled with heavier market concentration, the likelihood of encountering such legal burdens may increase, furthering reducing the incentive of banks to make illiquid loans. This effect is only relevant for small banks possibly because of their weaker economic and political bargaining power.

### 4.6 Alternative explanations:

The conclusions we have made so far include that bank equity capital is strongly negatively associated with liquidity creation, market power strongly contributes to liquidity creation, and market concentration helps or hinder liquidity creation depending on the size of banks and the group of countries. Even though we have included in our regression so far control variables that cover deposit insurance, macroeconomic environment and accounting method, there are other institutional factors that may compound with our existing findings. In particular, we address in this section creditor rights and foreign ownership.

[27] During the rescue of Fortis Bank by the government of Belgium, Luxembourg, and the Netherlands in 2008, equity holders are essentially wiped out. The association of angered former Fortis shareholders resort to legal procedure to try to recover their investment from the Finance ministries of Belgium and the Netherlands. For more than a year, the association could not even find out if the governments will provide an explanation or not, let alone financial compensations.

**Table IV**

**The asymmetry between asset and liability parts of liquidity creation**

This table reports the results of regressions on the asset and liability components of the cat fat liquidity creation measurement   Also included in the regressions is the full set of control variable as reported in Table III, year dummies and bank fixed effects, and a constant. Their coefficients are not reported for brevity. The Market share and Market concentration in this table are measured using the asset or liability part of the liquidity creation. The regressions are separately run for European banks using the sample of the developed EU15 and Switzerland, and the sample of developing or Ascending EU counties. The samples of large and small banks are also treated separately. The dependent variables are the post-weighting asset and liability parts of the cat fat liquidity creation measurement respectively. A banks/year observation is defined as large (small) if the total assets is equal or above (below) € 1 billion. The definitions of the explanatory variables can be found in Table II. All explanatory variables used are lagged by one year. The sample is unbalanced and covers the period from 1998 to 2004. Reported t-statistics in the parenthesis are clustered at the bank level. Reported t-statistics in the parenthesis are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1% level respectively.

| | **Large banks** | | | | **Small Banks** | | | |
|---|---|---|---|---|---|---|---|---|
| | **EU15 + Switzerland** | | **Ascending EU** | | **EU15 + Switzerland** | | **Ascending EU** | |
| | **Asset** | **Liability** | **Asset** | **Liability** | **Asset** | **Liability** | **Asset** | **Liability** |
| **Cap Ratio** | -0.193* | -0.195*** | -0.452 | 0.189 | -0.178*** | -0.083*** | 0.046 | 0.043 |
| | (-1.703) | (-3.802) | (-1.632) | (0.930) | (-4.316) | (-4.463) | (0.647) | (1.217) |
| **Market share** | 2.756*** | 2.357*** | 3.986*** | 0.061*** | 7.116*** | 5.346*** | 2.314*** | 0.110** |
| | (8.292) | (7.781) | (10.258) | (5.296) | (7.296) | (6.330) | (7.017) | (1.968) |
| **Marke concentration** | -1.226** | -2.870*** | -4.525 | 0.326 | -7.310*** | -7.223*** | 1.239 | -0.248 |
| | (-2.454) | (-5.043) | (-1.490) | (0.751) | (-5.412) | (-6.567) | (0.993) | (-1.047) |
| **Creditor rights** | 0.703 | -1.815*** | -9.192 | -3.050** | -6.808*** | -4.996*** | 11.876** | -5.002*** |
| | (0.803) | (-2.788) | (-0.995) | (-2.032) | (-7.144) | (-8.728) | (2.339) | (-4.765) |
| **Creditor rights * Market concentration** | -0.239 | 1.337*** | 1.003 | -0.109 | 1.817*** | 2.867*** | -1.676*** | 0.082 |
| | (-0.637) | (2.755) | (0.757) | (-0.754) | (2.631) | (7.132) | (-2.585) | (1.043) |
| **Year dummies** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Bank Fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **$R^2$** | 0.246 | 0.423 | 0.617 | 0.543 | 0.283 | 0.512 | 0.44 | 0.42 |
| **Observations** | 6503 | 6503 | 218 | 218 | 13686 | 13686 | 551 | 551 |

### 4.6.1 Creditor rights, market concentration, and liquidity creation

As we argued in Section 4.3.4 that the power brought to banks in highly concentrated market may depend on the creditor rights of a country. Specifically, it has been shown that banks in countries with stronger creditor rights collectively issue more loans to the private sector (Djankov et al 2007). The effect of market power may be conditional on the strength creditor protection in a country. Highly concentrated market and the associated market power may not be materialized if weak creditor protection prevents the banks from recouping part of their losses in the event of default or contract breach, which effect increases the expected loss of the banks and reduces banks' willingness to deal with risky borrowers. In addition to settling default event, banks may also encounter other loss-generating events during the course of a loan if their creditor rights are weak.

We examine the potential impact of creditor rights on liquidity creation by including both the creditor right itself and its interaction with market concentration. Also included are the dummy variables that control for the legal origins of the sample countries. We do not interact creditor rights with individual bank's market share because all banks in a country face the same level of creditor protection. The interaction between market share and creditor rights therefore does not capture additional variation between banks in a country. As shown in Table V, creditor rights indeed play a significant role in bank liquidity creation. Note the coefficients of the interaction term is significantly positive for both large and small banks in EU15, which supports our conjecture that it is indeed the combination of stronger market power and higher level of creditor protection that jointly contributes to bank liquidity creation. As can be seen in the summary statistics in Table II, EU15 countries on average have higher scores in creditor rights than the Ascending EU. Our results in EU15 there support the findings by Djankov et al (2007) that banks operating in countries with better creditor protection create more liquidity.

On the contrary, the coefficients of the interaction term in the regressions for Ascending EU are either non-existence in the case of large banks or significantly negative for small banks. The results for small banks imply that holding market share and market concentration constant banks operating in countries with stronger creditor rights create less liquidity. Such a seemingly counterintuitive result may be explained by looking at what exactly we used in the regression as the proxy for creditor rights.

**Table V**
**Disentangle competition from institutional factors**

This table reports the results of regression with the inclusion in the models reported in Table III of creditor rights, the interaction of creditor rights and market competition, and legal origins. Also included in the regressions is the full set of control variable listed in Table II, year dummies and bank fixed effects, and a constant. The coefficients for the control variables are not reported for brevity. The regressions are separately run for European banks using the whole sample, the sample of the developed EU15 and Switzerland, and the sample of developing or Ascending EU counties. The samples of large and small banks are also treated separately. The dependent variable is the ratio of the Cat Fat liquidity creation measure to total assets. A banks/year observation is defined as large (small) if the total assets is equal or above (below) € 1 billion. The definitions of the explanatory variables can be found in Table II. All explanatory variables used are lagged by one year. The sample is unbalanced and covers the period from 1998 to 2004. Reported t-statistics in the parenthesis are clustered at the bank level. Reported t-statistics in the parenthesis are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1% level respectively.

| | Large banks | | | Small banks | | |
|---|---|---|---|---|---|---|
| | Whole Sample | EU15 + Switzerland | Ascending EU | Whole Sample | EU15 + Switzerland | Ascending EU |
| **Cap Ratio** | -0.534*** | -0.554*** | -0.149 | -0.451*** | -0.448*** | -0.275*** |
| | (-4.077) | (-4.240) | (-0.313) | (-9.936) | (-9.396) | (-2.673) |
| **Market share** | 0.532*** | 0.562*** | 0.593*** | -0.091** | 108.751*** | 0.016 |
| | (4.612) | (3.491) | (3.645) | (-2.052) | (7.826) | (0.148) |
| **Marke concentration** | -0.267** | -0.249** | 0.149 | -0.073 | -0.088* | 3.477*** |
| | (-2.388) | (-2.105) | (0.074) | (-1.576) | (-1.902) | (4.703) |
| **Creditor rights** | -4.433*** | -3.403*** | -9.675 | -6.431*** | -8.748*** | 23.339*** |
| | (-3.962) | (-2.846) | (-0.650) | (-6.613) | (-7.956) | (3.541) |
| **Creditor rights * Market concentration** | 0.116** | 0.122* | 0.000 | 0.072*** | 0.120*** | -1.754*** |
| | (2.021) | (1.855) | (0.000) | (2.682) | (4.769) | (-5.176) |
| **English legal origin** | 6.619* | 4.184 | (Dropped) | -7.867** | -6.867* | (Dropped) |
| | (1.847) | (1.172) | | (-2.367) | (-1.934) | |
| **French legal origin** | 9.067*** | 8.861*** | -3.730 | -10.389*** | -12.649*** | -13.752 |
| | (5.166) | (4.144) | (-0.448) | (-7.822) | (-8.048) | (-1.395) |
| **Nordic legal origin** | 4.015 | 2.547 | (Dropped) | 13.700*** | 6.806*** | (Dropped) |
| | (0.854) | (0.501) | | (6.495) | (2.991) | |
| **Year dummies** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Bank Fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| **$R^2$** | 0.181 | 0.183 | 0.483 | 0.317 | 0.386 | 0.178 |
| **Observations** | 6721 | 6503 | 218 | 14237 | 13686 | 551 |

As explained in Table III, the variable we used to measure the strength of a country's creditor rights is an aggregate score that integrates four accounts of legal institutions relevant for debtors financial claims against the borrowers. Essentially, these institutions can be seen as the existence of certain legal procedures that debtors can rely on when there are financial disputes. Djankov et al (2003) suggest that the existence of formal legal procedures in less developed countries could actually result in inefficiency and injustice. Our finding of a negative impact on liquidity creation by stronger creditor rights may be explained by the adverse effect of the legal formalism in the less developed Ascending EU. The fact that the effect is particularly strong for small banks but absent for large banks could be explained by the relatively weak economic or political significance enjoyed by small banks, which could make them more vulnerable than large banks to cumbersome or unfair legal procedures.

### 4.6.2 Foreign ownership

We have hinted before that the majority of large banks in Ascending EU are foreign-owned. In this subsection, we formally substantiate this issue. To this end, we gathered detailed bank-level ownership data for our European sample for a sub-sample period from 1998 till 2002[28]. As can be seen in Table VI, among the four groups of distinguish, large banks in Ascending EU is the only one that demonstrates consistent foreign dominance. As we argued before, the liquidity creation by foreign banks may be different from local banks because banks that have presence in different countries may be more capable of diversifying risks among broader customer base and therefore creating more liquidity. On other hand, foreign banks may not have as much knowledge about the local market as the local competitors, which could force them to resort to arm's length lending rather than relationship lending and hence reduce their liquidity creation.

In order to clarify the real effect of foreign ownership, we include in our regressions a dummy variable that equals 1 in a bank is owned by foreigners. We also include an interaction terms between foreign ownership dummy and individual banks' market share. The interaction term helps further answer the question if foreign owned banks with higher market share behave differently in liquidity creation. It also addresses the doubt that if our previous findings on market share is driven by ownership.

[28] We are grateful for Ugo Panizza for providing us the data he together with Alejandro Micco and Monica

**Table VI**
**Distribution of foreign ownership**

This table presents the number of domestically versus foreign owned banks for a sub-sample covering 1009 to 2002. All years have two entries: a value of 0 means foreign ownership is below or equal to 50%; a value of 1 means the percentage of foreign ownership is above 50% implying that the bank is owned by foreigners. The sample is split between EU15+Switzerland and the Ascending EU countries, and then further split between large banks (total assets equal or above 1 billion Euro) and small banks (total assets below 1 billion Euro).

| | EU15 + Switzerland | | | |
|---|---|---|---|---|
| | Large banks | | Small banks | |
| Year | >50% Foreign owned (1=Yes) | Frequency | >50% Foreign owned (1=Yes) | Frequency |
| 1998 | 0 | 631 | 0 | 2392 |
| 1998 | 1 | 103 | 1 | 147 |
| 1999 | 0 | 673 | 0 | 2109 |
| 1999 | 1 | 119 | 1 | 135 |
| 2000 | 0 | 705 | 0 | 2318 |
| 2000 | 1 | 138 | 1 | 138 |
| 2001 | 0 | 719 | 0 | 2199 |
| 2001 | 1 | 144 | 1 | 126 |
| 2002 | 0 | 706 | 0 | 1723 |
| 2002 | 1 | 143 | 1 | 117 |
| | Ascending EU | | | |
| | Large banks | | Small banks | |
| 1998 | 0 | 5 | 0 | 57 |
| 1998 | 1 | 13 | 1 | 25 |
| 1999 | 0 | 4 | 0 | 48 |
| 1999 | 1 | 19 | 1 | 25 |
| 2000 | 0 | 5 | 0 | 57 |
| 2000 | 1 | 23 | 1 | 33 |
| 2001 | 0 | 9 | 0 | 63 |
| 2001 | 1 | 22 | 1 | 43 |
| 2002 | 0 | 11 | 0 | 48 |
| 2002 | 1 | 23 | 1 | 45 |

Table VII reports the regression results. Our previous results on market share all survived. In all cases, individual banks' market share significantly contributes to liquidity creation. These results do not appear to be driven by foreign ownership. Yet the inclusion of foreign ownership yields some additional insights. Foremost is the significantly negative sign for the interaction between market share and foreign ownership for large banks in Ascending EU. This means as the market share of large foreign banks in Ascending EU grows bigger, they create less liquidity. For small foreign banks operating in Ascending EU on the other hand, the effect of market share does not interact with ownership. Foreign ownership appears to be strictly beneficial for liquidity creation. Together these contrasting results for Ascending EU countries between large and small banks suggest it is likely that the expansion by large

Yanez used in Micco et al (2007).

banks in Ascending EU is mainly into the provision of standard and liquid banking product that do not improve liquidity creation. Small banks on the other hand are more likely to rely on relationship lending even when they expand to other country, which improve their liquidity creation. Alternatively, since we measure the size of banks based on their country level operations (e.g., if a large banks' foreign assets in a country is below € 1 billion, then it is considered a small bank in that country), our results can also be interpreted as saying that a bank creates more liquidity abroad when it's foreign presence is small, but creates less liquidity when its market power is sufficiently large.

For EU15 countries, small foreign owned banks, or the small-scale operation by foreign banks, create less liquidity than their domestic counterparts. This result suggests that the customers of small banks in the more developed EU15 are more inclined to deal with the domestic lenders possibly due to the information advantage of these lenders regarding the local customers.

### 4.7 Robustness check with Alternative sample using minimum adjusted Bankscope data

The sample we used till this point is a combination of Bankscope data and manually collected bank balance sheet data. We deem the manual data collection effort necessary because it alleviates the lack of details in Bankscope data required for building the Berger and Bouwman (2009) preferred liquidity creation measurement. We illustrate this point in Table VIII where we run the regressions using the original Bankscope data adjusted only for the deposit items with the average deposit ratios of the corresponding deposit items from the manually collected banks. The results show that while the results for Cap Ratio are consistent with our previous results, the results for Market Concentration are different particularly for Ascending EU. This means our manually collected data contribute to the correct establishment of the relationship between liquidity creation and market concentration.

**Table VII**

**Regressions of liquidity creation also controlling for foreign ownership**

The regressions models reported in this table are built on those in Table III. Additional regressors include a dummy that equals 1 when more than 50% of the total assets of a bank/year is foreign owned, and the interaction of this dummy and market share. Also included in the regressions is the full set of control variable also present in the models in Table III and IV, year dummies and bank fixed effects, and a constant; the coefficients for these variables are not reported for brevity. The regressions are separately run for European banks using the whole sample, the sample of the developed EU15 and Switzerland, and the sample of developing or Ascending EU counties. The samples of large and small banks are also treated separately. The dependent variable is the ratio of the Cat Fat liquidity creation measurement to total assets. A banks/year observation is defined as large (small) if the total assets is equal or above (below) € 1 billion. The definitions of the explanatory variables can be found in Table II. All explanatory variables used are lagged by one year. The sample is unbalanced and covers the period from 1998 to 2004. Reported t-statistics in the parenthesis are clustered at the bank level. Reported t-statistics in the parenthesis are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1% level respectively.

| | Large banks | | | Small banks | | |
|---|---|---|---|---|---|---|
| | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** |
| **Cap Ratio** | -0.202* | -0.182 | -0.969 | -0.456*** | -0.435*** | -0.300** |
| | (-1.799) | (-1.602) | (-1.490) | (-6.305) | (-5.661) | (-2.316) |
| **Market share** | 0.433*** | 0.524*** | 1.381*** | 0.383 | 85.306*** | 1.463** |
| | (3.477) | (2.603) | (4.219) | (0.705) | (7.192) | (2.274) |
| **Foreign owned** | 1.310 | -0.337 | 22.181*** | -2.813* | -5.492*** | 8.433** |
| | (0.856) | (-0.209) | (3.250) | (-1.762) | (-2.652) | (2.516) |
| **Foreign owned * Market share** | -0.134 | 0.316 | -1.213*** | 0.008 | 25.287 | -0.639 |
| | (-0.986) | (1.132) | (-3.568) | (0.014) | (0.805) | (-1.003) |
| **Marke concentration** | -0.780*** | -0.738*** | 6.175 | -0.264** | -0.118 | 3.862 |
| | (-4.192) | (-3.857) | (0.865) | (-2.224) | (-0.922) | (1.539) |
| **Creditor rights** | -8.840*** | -6.818*** | 45.536 | -6.499*** | -6.198*** | 19.023 |
| | (-5.257) | (-3.875) | (0.728) | (-4.507) | (-3.602) | (1.428) |
| **Creditor rights * Market concentratio** | 0.246*** | 0.233** | -2.134 | 0.156*** | 0.127*** | -1.536* |
| | (2.753) | (2.566) | (-0.762) | (3.546) | (2.751) | (-1.651) |
| **Year dummies** | Yes | Yes | Yes | Yes | Yes | Yes |
| **Bank Fixed effects** | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.265 | 0.271 | 0.557 | 0.298 | 0.358 | 0.212 |
| **Observations** | 2869 | 2780 | 89 | 8062 | 7777 | 285 |

## 4.8 Conclusions

In this paper, we investigate bank liquidity creation using a unique and comprehensive dataset that covers the majority of banks in EU for the period between 1998 and 2004. First, we quantify the amount of liquidity created by EU banks by aggregating bank balance items weighted according to their position on the balance sheet and their liquidity characteristics. Illiquid assets and liquid liabilities positively contribute to liquidity creation while liquid assets and illiquid liabilities reduce liquidity creation. We take into account both on- and off-balance sheet items. Our results corroborate with the literature on financial system comparison that suggests European economies rely more on bank financing. The amount of liquidity created by European banks as a percentage of GDP is much higher than banks in the U.S.

Next, we investigate the relationship between bank equity can liquidity creation and thereby shed lights on the potential impact of the recent shift in regulatory focus on strengthening bank capital base. Our results show that increased bank equity capital would substantially reduce bank liquidity creation by all banks across Europe. The reason is the history of consistent government intervention and protection during banking crisis and the resulting ideology that banks will never be allowed to fail.

**Table VIII**

**Robustness check —Bankscope database with minimum adjustment**

This table reports the results of robustness checks using the original Bankscope data only adjusted for the deposit items based on the manually collected data. Also included in the regressions is the full set of control variable also present in the models in Table III, year dummies and bank fixed effects, and a constant. The coefficients for the control variables are not reported for brevity. Results are separately reported for European banks using the whole sample, the sample of the developed EU15 and Switzerland, and the sample of developing or Ascending EU counties. The samples of large and small banks are also treated separately The dependent variable is the ratio of the cat fat liquidity creation measure to total assets. A banks/year observation is defined as large (small) if the total assets is equal or above (below) € 1 billion. The dummy variable accounting equals one if the bank/year observation is under the IFRS accounting rules. The definitions of other explanatory variables can be found in Table II. All explanatory variables used are lagged by one year. The sample is unbalanced and covers the period from 1998 to 2004. Reported t-statistics in the parenthesis are clustered at the bank level. Reported t-statistics in the parenthesis are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1% level respectively.

| | Large banks | | | Small banks | | |
|---|---|---|---|---|---|---|
| | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** | **Whole Sample** | **EU15 + Switzerland** | **Ascending EU** |
| **Cap Ratio** | -0.577*** | -0.586*** | 0.053 | -0.456*** | -0.466*** | -0.349*** |
| | (-3.985) | (-4.020) | (0.083) | (-10.776) | (-10.304) | (-3.649) |
| **Market share** | 0.247*** | 0.289** | 0.242 | 0.393** | 52.834*** | 0.757*** |
| | (2.842) | (2.263) | (1.571) | (2.150) | (5.296) | (3.332) |
| **Marke concentration** | -0.006 | -0.045 | 0.486 | -0.095*** | -0.148*** | 0.109 |
| | (-0.116) | (-0.916) | (0.864) | (-3.501) | (-5.265) | (0.434) |
| **Creditor rights** | -3.454*** | -3.416*** | -7.728 | -6.562*** | -9.379*** | -7.701** |
| | (-3.337) | (-3.228) | (-1.230) | (-7.768) | (-9.883) | (-2.103) |
| **Creditor rights * Market concentration** | -0.006 | 0.035 | -0.123 | 0.100*** | 0.150*** | -0.105 |
| | (-0.132) | (0.710) | (-0.402) | (3.647) | (5.342) | (-0.732) |
| **Deposit insurance** | -0.833*** | -0.817*** | -1.660*** | -0.631*** | -1.091*** | 0.091 |
| | (-4.208) | (-3.747) | (-2.849) | (-4.768) | (-7.683) | (0.324) |
| **$R^2$** | 0.183 | 0.182 | 0.446 | 0.438 | 0.489 | 0.169 |
| **Observations** | 6490 | 6308 | 182 | 13985 | 13511 | 474 |

Additionally, we show that the market share of individual banks substantially contributes to liquidity creation. We take this as evidence on the stronger ability possessed by banks with larger market share to retain customers and inter-temporally smooth interest charges so that risky and illiquid loans can find financing to start with. More investments in these loans in turn increase bank liquidity creation.

## Appendix: Construction of liquidity creation measure and data items

The Cat Fat liquidity creation measure is calculated according to the following formula:

Cat fat = 0.5*illiquid assets (cat) + 0*semi-liquid assets (cat) – 0.5*liquid assets
+ 0.5*Illiquid Guarantees
+0.5*liquid liabilities + 0*semi-liquid liabilities – 0.5*illiquid liabilities – 0.5*equity

where each of the individual components can be grouped and further decomposed as follows:

**ASSETS:**

Illiquid assets = (Total Customer Loans 5190 – Loans to Municipalities or Government 5100
– Loans to Banks 5170)
+ Other Investments 5540
(+ Total Non Earning Assets 5620 – Cash and Due from Banks 5580)
+ Total Fixed Assets 5660

Semi-Liquid assets = Loans to Municipalities or Government 5100
+ Loans to Banks 5170
+ Deposits with Banks 5350
+ Due from Central Banks 5360
+ Due from Other Banks 5370
+ Due from Other Credit Institutions 5380
+ CDs 5520
+ Non-Listed Securities 5430

Liquid assets = (Total Securities 5470 – Non-listed Securities)
+ Treasury Bills 5490
+ Other Bills 5500
+ Bonds 5510
+ Cash and Due from Banks 5580
+ Equity Investments 5530

**LIABILITIES:**

Liquid liabilities = Demand Deposits 5920
+ Savings Deposits 5925
+ Deposits with Banks 6060
+ Commercial Deposits 6050

Semi-Liquid liabilities = Time Deposits (5930 5940 5950 5970 5980
+ Municipalities or Government Deposits 6010
+ Other Deposits 6030
+ Total Money Market Funding 6160

Illiquid liabilities+ Equity = Total Other Funding 6240
+ Total Loan loss and Other Reserves 6280
+ Other Liabilities 6285
+ Total Equity 6400

**OFF-BALANCE SHEET GUARANTEES:**

Illiquid Guarantees = Total Contingent Liabilities 7110

# Chapter 5

## Summary and Conclusions

Commercial banks have always been of great public and academic interests. More so than before, in recent years, they have increasingly become a point of focus, concern, and debate. At the time of this writing, the subprime crisis and the subsequent global financial meltdown put banks and financial institutions in general under the spotlight and scrutiny of the general public and policy-makers. Undoubtedly, commercial banks are crucial to the wellbeing of the individuals and the general economy of the modern society.

This dissertation examines three topics that are centered on commercial banks and are of interest to different groups of stakeholders of these financial institutions. Chapter 2 has the shareholders of commercial banks as the intended audience. It investigates the excess stock returns of banks in a cross-sectional setting using the popular methodology of Fama and French (1992). Unlike the limited amount of existing literature focusing on bank stock returns, this paper does not assume the validity of the pricing factors found to be important in the non-financial sectors. Instead, pricing factors are largely independently extracted from the literature of financial intermediation and banking economics. The results show, maybe unsurprisingly, that leverage and beta, pricing factors found to be irrelevant to non-financial sectors, are important to bank stock returns. Leverage is strongly positively related to bank stock returns, and beta demonstrates a convex relationship with bank stock returns. Finally, size, measured by total assets rather than capitalization, has a strong and negative relationship with bank stock returns. All in all, the results of this chapter suggest that the investigation of stock returns of banks or financial institutions can benefit from the theories oriented towards these sectors rather than heavily relying on the asset pricing literature of the non-financial sectors.

Chapter 3 examines the use of interest rate and credit derivatives by banks for hedging purposes. This chapter is motivated by the rapid growth of the derivative markets and the concerns with the heavy involvement of banks in these complex markets and products. By investigating the drivers behind the (increased) use of derivatives by individual banks, this chapter answers the question, among others, whether banks' loan making activities are closely tied with derivative markets. If so, any problem in the derivative market would also have severe consequences on the economy because borrowers would not be able to receive funding from banks given the reliance of banks on derivatives for risk mitigation.

To this end, Chapter 3 uses as the sample the data covering all U.S. banks that have hedged with derivatives for the period from 1997 to 2005 and document in details the relationship between derivative usage and a wide collection of bank characteristics and macroeconomic factors. The results show that for interest rate derivatives, it is not the on-balance sheet loans that drive banks to use derivatives. Rather it is the off-balance sheet unused loan commitment contracts that make banks more likely to be derivative users. The consequence of such a relationship is that if derivative market becomes insolvent, borrowers would not be able to rely on their established but yet unused source of bank financing for funding needs. This could be a severe problem because at least in the U.S. more than 80% of commercial and industrial loans are made through loam commitment arrangements. The problems in the derivative market could easily be translated into the starving of funding for the real economy.

Regarding credit derivatives, the most interesting findings include that the trading and hedging of credit derivatives are strongly correlated with each other and that hedging with credit derivatives and securitization are likely to increase at the same time.

Chapter 4 has the broadest scope of all chapters in this dissertation. This chapter covers the banking sectors of all EU countries and investigates a couple of questions with crucial policy relevance. Using a unique sample that includes the majority of banks in all EU25 countries and Switzerland, this chapter demonstrates a strong and negative relationship between bank equity capital and bank liquidity creation. This is an important consideration policy-makers need to take into account when reformulating the next generation of capital regulation framework. After the subprime crisis, regulators such as the Bank for International Settlements have proposed to revise the current Basel 2 framework and put stronger emphasis on banks to hold more capital. The results of chapter 4 suggest that the proposed regulatory focus may have the unwelcoming side-effect of reducing bank liquidity creation, which may slow down economic recovery and growth.

Another interesting finding in Chapter 4 is the relationship between liquidity creation and the competitive landscape of the banking sector. This chapter shows that whether or not concentration is beneficial to liquidity creation depends on the institutional context of a country. In particular, higher degree of market concentration or stronger market power of banks is beneficial when the creditor protection of a country is strong. Otherwise, market concentration would reduce liquidity creation in countries with weaker creditor protection.

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## EMPIRICAL ESSAYS ON THE STOCK RETURNS, RISK MANAGEMENT, AND LIQUIDITY CREATION OF BANKS

This thesis consists of three studies that respectively investigate the stock returns, risk management, and liquidity creation of banks. Chapter 2 focuses on the cross-section of expected bank stock returns and shows that leverage and beta are important for pricing bank stocks in the United States. During the two decades prior to the subprime crisis, banks with high leverage have high stock returns. Beta appears to have a convex relationship with bank stock returns. This chapter generally suggests that bank stocks seem to respond to a different set of pricing factors than other industries.

Chapter 3 examines the drivers behind banks' use of derivatives for hedging. Covering virtually all banks in the U.S. that have used derivatives, one key finding of this chapter is that off-balance sheet loan commitment contracts, rather than on-balance sheet loans, determines the use of derivatives for hedging. Since loan commitment contracts are the primary channel of bank financing for commercial and industrial borrowers, the implication of this finding is that the illiquidity of the financial market would make it difficult for firms to refinance their existing loans, which is consistent with the observation during the subprime crisis.

Finally, Chapter 4 examines the liquidity creation of banks in the European Union (EU) and its relationship with equity capital, market power, and institutional context. Using a unique and comprehensive sample of EU banks, this chapter shows that the impact of stronger capital base on bank liquidity creation is significantly negative. This means that capital regulations such as the Basel II Accord are likely to curtail banking activities and slow down economic recovery and growth in EU. Next, this chapter shows that stronger creditor rights coupled with stronger market power reduces bank liquidity creation in developing EU countries, and vice versa for developed EU countries. This finding suggests that due to less developed legal infrastructure, stronger creditor rights could be counterproductive in facilitating bank liquidity creation in developing countries.

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