Essays in Banking

Songshan Li

Doctor of Philosophy

University of York
Economics and Related Studies

September 2023

Abstract

The second chapter examines why do banks respond to an increase in capital requirements despite possessing sufficient buffers? We show that the extent to which banks expect to acquire private information regarding their assets is a key determinant of their response to higher capital requirements. Following an increase in capital requirements induced by the FAS 166/167 reforms, the average treated bank reduces risk-weighted assets. Our novel finding is that opaque banks - those with low trading assets - drive the average effect, despite receiving milder treatment. We explain the findings in a model where opaque banks face an adverse selection discount when selling assets.

In the third chapter, we use the global syndicated loan-level data from 2004-2016 and the staggered changes of creditor participation rights in seven countries to investigate how an increase in the creditor participation index affects the cost of credit in different democratic environments. We find evidence that stronger creditor participation rights reduce the cost of credit in the low democratic countries only. While in high democratic countries, the effect of an increased creditor participation index on spreads is statistically insignificant in most specifications. Our findings suggest that creditor participation rights are more valuable in low democratic countries.

Chapter four explores whether and how the use of interest rate derivatives can substitute for holding liquidity in banking in terms of bank risk management. I find that the banks that hold more interest rate derivatives for the hedging purposes have lower liquidity, suggesting that interest rate derivatives used for hedging are a substitute for liquidity. Derivatives held for the trading purposes are observed not to reduce banks' liquidity positions. The results are robust to several additional tests. Overall, my study contributes to understanding the substitution effects of financial derivatives usage for hedging on liquidity holding regarding bank risk management.

Table of Contents

List of Tables

List of Figures

Acknowledgements

First and foremost, I am deeply grateful and indebted to my supervisor Professor Kostas Koufopoulos for his continuous guidance, enthusiasm, and unwavering support throughout every stage of my PhD. He is a fantastic supervisor, always leading me by example with integrity, hard work, and selfless support. His supervision and knowledge have helped me develop not only knowledge about finance but also a critical research philosophy. I owe so much of what I have learned in my PhD to his dedication and support.

I also gratefully thank my co-author, Dr. Sonny Biswas, for his invaluable guidance and support. I have benefited greatly from working with Dr. Sonny Biswas who gave me lots of comments, suggestions, and support. His comments and suggestions improved this thesis a lot. I am deeply grateful for the opportunity to work with him and have learned so much from working with him. I am also thankful to my Thesis Advisory Panel members, Dr. Adam Golinski and Dr. Maryam Alhalboni, for their insightful comments. I thank my examiners, Dr Nikos Paltalidis and Professor Peter N. Smith, for an interesting discussion and many valuable comments.

I also want to thank my friends for their constant support, for their encouragement, for always having confidence in me.

Finally, my immense gratitude goes to my family, especially my loving parents, who always believe in me and support me at any time. I thank them for their unconditional love, caring, and support.

Declaration

I declare that this thesis is a presentation of original work and any material contained in this thesis has not been presented for a degree or other qualification at this, or any other, University. All sources are acknowledged as References.

I further declare that Chapters Two of this thesis is co-authored with Dr. Sonny Biswas and Professor Kostas Koufopoulos.

Chapter Three and Four are sole-authored. These chapters have been enriched with numerous discussions that I have had with Professor Kostas Koufopoulos and Dr. Sonny Biswas.

Songshan Li

York, September 2023

Chapter 1

Introduction

This thesis consists of three essays on banking. Chapter Two examines how banks respond to an increase in capital requirements, emphasising the role of asymmetric information in bank assets. Chapter Three focuses on the substitution effect of stronger creditor protection and democracy on the cost of credit. Chapter Four investigates how interest rate derivatives substitute expensive liquidity for bank risk management purposes.

Banking plays a pivotal role in the financial system. The primary tasks of banking are to allocate resources and manage risks. A more developed banking system is able to mitigate market frictions, allocate scarce resources to the most productive opportunities and alleviate financial instability. Previous literature has investigated the economic function of banks deeply. Banks perform as an intermediary to transfer liquidity between lenders and borrowers. A well-functioning bank can prompt a healthy, sustainable and prosperous financial system. However, the characteristics of banks expose them to more risks. If banks are not managed properly, the existence of banking can also hamper the stability and development of the financial system. Over the turbulent period of the last two decades, the importance of banks has been further highlighted at both the local and global levels. Banks are inherently fragile, as witnessed during the 2007-2009 financial crisis. The global financial crisis has shown us how devastating a negative shock to the banking system can be. One of the biggest lessons we learned from the crisis is that we need to understand the importance of banking capital structure and liquidity management in terms of bank operations. Motivated by the importance of the banking system, a set of macroprudential policies are designed by regulators to alleviate banking instability and improve the development of financial markets. For example, in response to the global financial crisis, Basel III is developed to improve the capital requirements based on Basel II and introduces liquidity requirements, aiming to strengthen the regulation, bank risk management and the stability of the banking system. Given the fragility and importance of the banking system, with particular focus on bank management, Chapters 2 and 4 pay attention to bank capital requirements and liquidity management. Additionally, the function of banking in lending supply to affect the real economy and the role of banking as a financial intermediary in the market have been increasingly considered and monitored by bank managers, borrowers, investors, and regulators. In Chapter 3, we focus on the global syndicated loan market to explore bank credit supply. Overall, the thesis aims to understand the prudential management and intermediary role of banking, and the major contribution of this work is covered in Chapters 2 to 4.

In Chapter Two, we investigate why and how banks respond to an increase in capital requirements, even when the requirements do not immediately bind given existing buffers. The importance of bank stability has been emphasized by the existing literature. The insights from these studies have encouraged regulators to put considerable effort into designing and implementing new policies to protect the stability of banks and the financial market. The resulting set of policies is referred to as macroprudential policies. Among this set of macroprudential policies, capital requirements are considered as the most important one for bank stability because holding higher capital implies that bank shareholders would bear higher losses in the event of default, and therefore have lower incentives to take risks. Since the 2007-2009 global financial crisis, the capital requirements have been further tightened under Basel III, especially for the most systemically important banks to curb excessive risk-taking. Given the increasing focus on incorporating heterogeneity into bank characteristics in the design of regulation (as in Basel III), it is of particular interest to understand how banks respond to changes in capital requirements. The existing literature has studied this question, but it overlooks the two important bank features which affect the banks' response to changes in capital requirements, i.e., the level of capital buffers that a bank holds, and the extent to which a bank expects to acquire private information over its assets. In this context, the novelty of this chapter is that we argue theoretically and present empirical evidence to identify a characteristic which differs across banks, i.e., the informational asymmetry associated with bank assets, as a key determinant to critically affect banks' response to higher capital requirements.

We present a stylized model to test whether there are differences in banks' response to a higher capital requirement across banks with different transparency of their assets. In the model, there are two types of banks: one type has superior information about the quality of its assets over time (i.e., opaque banks), and the other type does not have private information about the quality of its assets (i.e., transparent banks). We assume that the capital requirements increase at the initial stage and there may be a negative shock to banks' untraded assets at a future date. Banks do not need to respond to the increase in capital requirements immediately because we assume they hold sufficient capital buffers. However, if the negative shock realizes, banks would need to sell risky assets in order not to breach the regulatory requirements. The negative shock is privately observed by each bank. Opaque banks will sell more risky loans even without the negative shock to benefit from the pooling price, and hence they will face an adverse selection discount if they sell their loans after gaining private information about their loan quality. Therefore, opaque banks will sell their assets on which they expect to acquire private information immediately after capital requirements are increased to avoid the adverse selection discount. In contrast, transparent banks do not face the adverse selection discount because the quality of their assets is transparent; as a result, they do not need to sell their assets to respond to the increase in capital requirements unless the negative shock realizes.

We show that banks with transparent assets (i.e., no anticipated information advantage) respond differently to higher capital requirements than banks with opaque assets. Specifically, opaque banks rely on reducing risk-weights to de-lever more than transparent banks. We use the FAS 166/167 reforms for identification and provide an explanation for why banks respond to an increase in capital requirements, even when the requirements do not immediately bind.

Our identification relies on the implementation of the FAS 166/167 in 2010. Following the implementation of the FAS 166/167, banks were required to consolidate Variable Interest Entities (VIEs) onto their balance sheets. The VIEs consolidation led to a mechanical fall in the level of the risk-weighted capital ratio, because the VIEs were included in the calculation of the risk-weighted assets. Our sample consists of annual bank-level data for US Bank Holding Companies (BHCs) during the 2005-2015 period. We identify 36 banks which consolidated VIE assets between 2011 and 2015; these make up the treated banks. We identify an additional 62 securitizing banks which are comparable in size and these make up the control banks.

We find that, on average, in response to the increase in capital requirements, treated banks rely on reducing risk-weighted assets (the denominator) to decrease leverage, rather than increasing their Tier 1 capital (the numerator). Economically, the implementation of the FAS 166/167 reforms reduces the risk-weighted assets by 3.28%, on average. Additionally, our model predicts that banks' response to the increased capital requirements differs across transparent and opaque banks. We interact the average treatmen etffect with trading assets (as a fraction of total assets) to test the cross-sectional differences across transparent and opaque banks. We find that the average effect that treated banks increase their risk-weighted capital ratio to respond to the increased capital requirements is driven by the more opaque banks. To achieve a higher risk-weighted capital ratio, opaque banks rely mostly on reducing their risk-weighted assets, which is consistent with the prediction of our model. We provide a theoretical argument and supporting empirical evidence that the informational asymmetry associated with bank assets is a key determinant that affects banks' response to an increase in capital requirements, which is the key contribution of this chapter.

In Chapter Three, we examine how the cost of credit is affected by the interaction of an increase in creditor participation rights and democracy by looking at the global syndicated loan markets. Bodie & Merton (1998) state that the majority function of financial markets is to allocate resources across different market participants. As the most important participant in financial markets, banking is the most prominent external funding provider for firms in the world. Bank credit supply is essential for firms' financing and investment decisions, which will directly affect the development of the real economy. Rajan & Zingales (1996) point out that banks can foster economic growth by providing loans to firms at lower spreads. When lending to a firm, a bank must consider not only the loan quality and riskiness of the borrower but also the risks coming from the legal conditions and the political regime of the borrower's country. The level of creditor protection impacts loan spreads by affecting the ability in reorganization and liquidation process in the event of borrowers' default. When creditor protection is high, banks will provide favourable loan contract terms since they are entitled to control the insolvency process and have rights to the property of a bankrupt firm, and hence they know that they will be able to be paid more assets ex post in the event of bankruptcy. Previous papers conclude that stronger creditor rights lead to the provisions of loans with a lower price (see, Qian & Strahan 2007, Bae & Goyal 2009).

Meanwhile, the level of democracy also impacts the loan contract terms. In democratic countries, there is a better flow of information and a more well-developed market (Acemoglu et al. 2019). For example, Acemoglu et al. (2019) point out that democratization can provide a higher GDP by improving fiscal capacity and social welfare, and also by increasing investment opportunities and reducing social conflict. Recent literature reports that democratization can benefit the economic development (Rodrik & Wacziarg 2005, Papaioannou & Siourounis 2008, Acemoglu et al. 2019). In addition, emerging bodies of literature report that credit can also benefit more from higher democratization (Delis et al. 2020, Osei-Tutu & Weill 2020) because of an increased information flow. The conclusion from these two lines of literature is that both the legal protection and the political regime negatively affect the cost of credit. Having reached this conclusion, the highlight of the analysis has shifted to understanding how the interaction of creditor protection and democracy affects the cost of credit.

In order to empirically explore the interaction impact between creditor protection and democracy, we use an exogenous increase in the creditor participation index to investigate how an increased creditor participation right affects the cost of credit in high and low democratic countries, respectively. Specifically, we use the staggered increases of creditor participation rights in seven countries during 2004-2014 to examine whether a stronger creditor participation right affects the cost of credit differently when we look at democratic countries versus autocratic countries. We use the Polity IV country-year measure for the institutional democracy level to define a treated country as a high (resp. low) democratic country if the average value of *Democracy* for that country is above (resp. below) the median. Within the treated countries, we classify four countries as high democratic countries and three as low democratic countries. Furthermore, we employ the global syndicated loan-level data from the Loan Pricing Corporation (LPC) DealScan database. We focus on the syndicated loan market since it provides an ideal laboratory to test the loan pricing of banks. First, syndicated loans are the prominent external financing source of large firms. Second, the Dealscan database provides very detailed coverage about syndicated loan facilities, which allows us to investigate how loan spreads are affected after controlling for the loan-level characteristics. Then, we match the loan-level information with the borrowers-level accounting data obtained from Compustat and the borrowers' country-level macroeconomic variables to have the final sample that we use.

One big challenge of this chapter is the empirical identification. Because of the staggered changes in creditor participation, the canonical difference-in-differences (DID) set-up would provide biased estimates. Recent econometric works note that the two-way fixed effects (TWFE) DID estimates in the staggered timing of treatment design are difficult to identify a straightforward weighted average effect of the treatment on the treated observations since the 'bad comparison' problem is introduced between already-treated units (De Chaisemartin & d'Haultfoeuille 2020, Borusyak et al. 2021, Baker et al. 2022). In order to implement a 'clean comparison' between treated and not-yet-treated units and identify an unbiased estimate under the staggered DID set-up, we use two separate approaches which are robust to the presence of heterogeneous treatment effects when the data are set with the staggered timing of treatment: an imputation approach proposed by Borusyak et al. (2021) and a two-stage difference-in-differences approach of Gardner (2022).

We find that the greater creditor participation rights decrease loan spreads in the low democratic sub-sample. An increase in the creditor participation index reduces loan spreads in the low democratic countries, ranging between 22 and 74 basis points - depending on the specifications. The impact of an increased creditor participation right on loan spreads is statistically insignificant (in most specifications) in the high democratic countries. Our findings suggest that a higher creditor participation right can reduce loan spreads in low democratic countries, but similar creditor participation will be less effective in high democratic countries. This indicates that stronger creditor participation rights are more valuable in autocratic countries. We highlight the substitution effect of creditor protection and democracy on the cost of credit, which is the key contribution of this chapter.

In Chapter Four, I explore whether and how financial derivatives can substitute liquidity in banking risk management. As the most important financial intermediary in the financial market, managing risks effectively and prudently is essential for a bank and the whole financial system both. A healthy banking system maintains financial stability and promotes economic development. At the same time, the instability of one bank may pose considerable systemic risks and expand to the whole market. A large number of studies has emphasized how bank instability distorts the development of the real economy. Therefore, it is necessary to take action for management, regulations, and government intervention in the banking system to ensure survival in uncertain climates. In addition, the main traditional bank activities are to provide liquidity and credit and transform risks (Bhattacharya & Thakor 1993, Kashyap et al. 2002, Berger & Bouwman 2009). Because of these fundamental activities, banks always pay attention to both solvency and liquidity. However, the focus on liquidity risks is scant compared to the attention to credit risks. In Basel I and II, the regulators pay attention to credit risks, market risks, and operational risks but ignore the importance of liquidity risks. The 2007-2009 financial crisis is one of the biggest shocks to the financial markets in the US and worldwide and highlights the critical importance of liquidity to both financial institutions and regulators. A lower liquidity holding in one bank may not only cause insolvency in itself but also affect the whole market. Especially at a time of recession, bank liquidity is crucial to guarantee financial stability. After the global crisis, the higher cost of liquidity and funding, the higher volatility and the lower confidence drives banks to exert more effort to manage their liquidity (Bank of Lithuania, 2011). In December 2010, Basel III introduce two liquidity ratios, the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR), - to force banks to manage their liquidity more prudently, which enhance banks' reputation and further reduce the possibility of a shortfall in liquidity. Keeping a certain level of liquidity could relieve banks' risk exposures since liquid assets are more easily converted into cash (Sinkey Jr & Carter 2000). However, it is noted that liquid assets are generally expensive because investing in these assets is less profitable, and hence, higher opportunity costs are attached to them. Moreover, maintaining liquidity requires bank managers to exert effort, which produces some administrative costs. Therefore, banks would only keep a minimum amount of liquid assets to meet the regulation requirements and ensure their smooth operations (Alim et al. 2021).

Banks have incentives to find alternative measures that are more effective and less expensive to manage risks. Besides the on-balance sheet approaches, banks also can use methods from the off-balance sheet to manage risk-taking. Off-balance sheet activities refer to activities that are not reflected on banks' balance sheets, including fees or commissions based on bank services, such as guarantees, endorsements, derivatives, et al. Since 1980s, bank off-balance sheet activities have increased dramatically. Financial derivatives are a sub-set of off-balance sheet contingencies and commitments and can be used to either hedge risks or speculate profits, which derive values depending on the value of their underlying assets. On the one hand, financial derivative instruments are argued to have the ability to manage banks' risk exposures effectively, as these instruments can be used to hedge volatility and banks' risks in an efficient manner. A growing number of works report that financial derivatives have served as a risk reduction tool for banks to manage risk-taking, supporting the hedging function of derivative instruments. On the other hand, the hedging view of derivatives has been suspected by bank regulators due to the speculative characteristics of derivatives. In particular after the 2007-2009 global financial crisis, the risks of financial derivative instruments have become more evident. It is unclear whether financial derivatives can work as a substitute for bank liquidity holding. Therefore, this chapter pays attention to the substitution effect of derivatives usage on bank liquidity in terms of risk management, which has not so far been explored in the extant literature.

I propose two hypotheses to predict the relationship between financial derivatives and bank liquidity holding and reveal the substitution effect. The derivative-hedging hypothesis points out that using interest rate derivatives for hedging purposes leads to lower liquidity. In contrast, the derivative-trading hypothesis argues that banks which use interest rate derivatives for trading purposes do not be incentivised to decrease their liquidity holdings. Thus, I examine whether and how the usage of interest rate derivatives affects bank liquidity, considering the different purposes for which derivatives are held.

I employ annual bank-level data for the US BHCs during the sample period of 2012-2019 to study the impact of using derivatives on liquidity by regressing the interest rate derivatives with different purposes on bank liquidity measures (i.e., *Liquidity Ratio*, and *Liquid Assets/TA*). I find that the banks using interest rate derivatives for the hedging purposes effectively reduce their liquidity holding, while the ones using them for the trading purposes do not lessen their liquidity. My finding suggests that the effect of interest rate derivatives usage on bank liquidity differs depending on the purpose - hedging versus trading. My results emphasise that the substitution effect of derivatives on bank liquidity only occurs when the derivatives are used for hedging, which is the key contribution of this chapter. Furthermore, I find that the effects of interest rate derivatives usage for hedging purposes on reducing liquidity are stronger for safer banks, as riskier banks face a relatively more binding liquidity requirement. In addition, due to the close correlation between bank safety and solvency, safer banks always have higher solvency, which makes it easier for them to raise funding from external investors. However, for riskier banks, they are close to insolvency, which makes them less likely to attract external finance. Hence, they have more incentives to hold a higher level of liquidity to cover the potential risk exposures. By including an interaction term between the use of interest rate derivatives for hedging purposes and an indicator variable of safer banks, I empirically find that the substitution effect of interest rate derivatives with the hedging purposes on liquidity in banking is stronger for the safer banks.

In Chapter Five, I summarise the findings of this thesis and discuss the policy implications and future research.

Chapter 2

Bank response to higher capital requirements under anticipated adverse selection *(with Dr. Sonny Biswas and Prof. Kostas Koufopoulos)*

2.1 Introduction

Capital requirements are the most prominent macro-prudential instrument in the arsenal of bank regulators. Since the global financial crisis of 2007-2009, requirements have become more stringent under Basel III to curb excessive risk-taking. An important question which arises here is how banks respond to changes in capital requirements. Several existing empirical papers have considered this question (e.g., Gropp et al. 2019) but they do not capture how two important bank features affect banks' response to the change in capital requirements. These features, which have been discussed widely in the last three decades, are: First, banks often keep large capital buffers in excess of the minimum capital requirements (e.g., Berger et al. 1995). Second, it has been argued that banks gain private information about the true value of (some of) their assets over time (e.g., Parlour & Plantin 2008, Dang et al. 2017) . In this context, the contribution of this paper is to argue theoretically and present supporting empirical evidence that information asymmetry associated with bank assets is a key determinant of banks' response to a change in capital requirements.

Model preview. We present a model which predicts that banks' response to higher capital requirements depends critically on the transparency of their assets. Suppose that there are two types of banks: one type owns informationally opaque assets (e.g., loans) and the other type owns more marketable assets (e.g., trading assets). Would the two types of banks respond differently to an increase in capital requirements?

In the model, when the increase in capital requirements is imposed banks do not have superior information about the quality of their assets; they only know the expected quality, which is also known to outside investors. Following the increase in capital requirements, banks learn the true quality of their assets over time. Opaque banks observe privately if their loans are of good or poor quality, while the quality of transparent banks' trading assets is publicly observed. Additionally, at a future date, there may be a negative shock to banks' untraded assets with some positive probability; the realization of the shock is privately observed by each bank. We assume that banks hold sufficient excess capital buffer such that the increase in capital requirements does not immediately lead to the violation of the requirements. However, if the negative shock to untraded assets realizes at the future date, a bank falls short of the regulatory capital requirements and needs to sell risky assets. Banks can sell risky assets either before or after they learn the quality of their tradeable assets.

If opaque banks sell their loans after they privately observe their loan quality, the proportion of bad loans sold will be higher than if they sell the loans before quality is observed. Because this negative shock is privately observed by banks, even banks which are not hit by the shock will sell their bad loans to benefit from the pooling price. Hence, the market applies an adverse selection discount if opaque banks sell their loans after they have observed the loan quality. Because of this adverse selection discount, opaque banks may breach the regulatory requirements if the negative shock hits and they sell their assets after they have gained private information about their true value. If they sell before they learn the true value of their loans, opaque banks will avoid the adverse selection discount and will meet the higher capital requirements even if the negative shock hits. Thus, opaque banks will sell the assets on which they expect to gain private information immediately after capital requirements are increased. In contrast, banks with transparent assets do not face the adverse selection discount since their asset quality is publicly observed; so, in response to the increase in capital requirements they need not sell risky assets, unless the negative shock to their untraded assets realizes. Beatty & Liao (2011) argue that it is difficult for banks to replenish regulatory capital in crisis periods (see also, Beatty & Liao 2014); our theory suggests that it is relatively more difficult to do so for banks which have mostly non-marketable assets.

Our model bears similarities with models in banking and corporate finance in which new information arrives and the information is private to some agents (e.g., Parlour &

Plantin 2008, Greenwood et al. 2015, Dang et al. 2017). In these models, informed and uninformed agents are allowed to trade only after the arrival of private information, and inefficiencies (from the ex-ante perspective) arise due to this private information. In contrast to existing models, we allow for trade to occur both prior to and after the arrival of the private information, and do not exogenously fix the timing of the trade. In equilibrium, parties can engage in trade prior to the arrival of the private information to avoid the adverse selection discount. This observation allows us to derive a new empirical prediction which is that banks with informationally opaque assets reduce risk-weighted assets more aggressively when there is an increase in capital requirements compared to banks which own more marketable assets.

Empirical setting. The ideal scenario to assess the impact of capital requirements would be if the regulators impose higher capital requirements on some randomly chosen banks, and not on others. By randomly chosen banks, we mean that the regulator does not consider bank size or systemic importance in choosing which banks are subjected to the higher capital requirements. In Basel II, changes in capital requirements are uniform across all banks in a jurisdiction and implemented at the same time for all banks, which means that there is no comparable group of banks against who the effects can be benchmarked. The various buffers introduced in Basel III give rise to some heterogeneity which may potentially be exploited for benchmarking. However, the buffers are imposed systematically, e.g., the largest banks are subject to higher requirements. The systematic nature of the regulation renders the benchmarking imperfect. In some cases (e.g., in the UK), the regulator imposes bank-specific requirements, but these correlate with potentially unobserved bank-specific characteristics.

Gropp et al. (2019) address some of these identification challenges by exploiting the institutional set-up of the 2011 capital exercise, conducted by the European Banking Authority (EBA) (see also, Bostandzic et al. 2022). The exercise targeted the largest banks in each EU member country. Since the largest banks in some EU member countries are smaller than some of the smaller banks in some other EU member countries, there is a size overlap between the banks chosen to be in the capital exercise and those that are left out. However, their set-up still suffers from the issue that the largest banks in any country are systemically more important from the perspective of that country, which makes them systematically different from the similar-sized banks from the other countries which are left out of the capital exercise. In support of this argument, Gropp et al. (2021) show that the individual governments of the EU member countries protected their largest banks from the new capital charges.

Our identification relies on the implementation of the FAS 166/167 in 2010. Under the previous relevant standard, FIN 46 (R), banks kept Variable Interest Entities (VIEs) mostly off the balance sheet. Following the implementation of the FAS 166/167, banks were required to consolidate the VIEs onto their balance sheets. Consolidation of the VIEs led to a mechanical fall in the level of the risk-weighted capital ratio, since the VIEs were included in the calculation of the risk-weighted assets. Important for our identification, the consolidation itself did not directly affect bank risk, since the banks were already exposed to most of the risk coming from these assets even before consolidation. As with Gropp et al. (2019), there is a considerable overlap between the size distributions of the treated and control banks. Additionally, since all our banks belong to the same jurisdiction, the United States, size is a reasonable proxy for the bank's systemic importance. Thus, our identification is not subject to the shortcoming in Gropp et al. (2019) that treated banks are likely to be more systemically important than the control banks.

Our setting has another advantage which is that capital requirements vary at the bank-level. Imbierowicz et al. (2018), Fraisse et al. (2020), De Jonghe et al. (2020) and Eckley et al. (2019), also consider settings in which capital requirements vary at the bank-level. In these settings the regulator exercises discretion in imposing the bank-level requirements, and hence, the requirements may be correlated with potentially unobserved bank-level factors. In our setting the requirements are correlated with observed bank-level factors and can be controlled for in the regressions.

Our sample consists of annual bank-level data for US Bank Holding Companies for the time-period between 2005 and 2015. To be included in our sample, we require that a bank has non-zero securitized assets in at least one year during the sample. This gives us an initial sample of 171 banks, of which 36 form the treated group since they consolidate VIE assets. Figure 2.1 shows the size distribution (in terms of the average total assets over the sample period) of the treated and control groups. Although the treated banks are larger on average, there is a considerable overlap in the size distributions of the treated and the control groups: the largest control bank in the sample is larger than 33 treated banks, and there are 62 control banks which are larger than the smallest treated bank. These 62 banks make up the control group in the final sample.

Empirical results. In response to an increase in capital requirements induced by the FAS 166/167 regulation, treated banks rely on reducing risk-weighted assets (the denominator) to reduce leverage, rather than increasing their Tier 1 capital (the numerator). The implementation of the FAS 166/167 reforms leads to a 3.28% fall in risk-weighted assets of the average treated bank and the effect is statistically significant at the 1% level. The result is striking since the mechanical impact of the reforms would be to increase the treated banks' risk-weighted assets if banks did not respond. That the treated banks' risk-weighted assets are lower relative to the control banks', suggests that the treated banks' response to the reforms was strong enough not only to neutralize but also to overturn the mechanical impact of the reforms. Overall, the treated banks increase their risk-weighted capital ratio following the reforms, relative to the control banks by around 1.1%. We show that our findings are not driven by the differential impact of the global financial crisis on the treated banks vis-à-vis the control banks.

Our model predicts that the impact of reforms differs across transparent and opaque banks. We conjecture that bank transparency is increasing in the fraction of trading assets. It may be the case that some trading assets are complex in nature (i.e., difficult to price), but transparency in our model is not related to complexity. When we say an asset is transparent, we mean that market participants have symmetric information about the state of nature, and it is opaque when banks have superior information. Since trading assets are held as short-term investments, banks which own these assets are unlikely to know more about these assets than outside investors. We interact the average treatment effect with trading assets (as a fraction of total assets) to test the cross-sectional differences across transparent and opaque banks.

Consistent with the prediction of our model, we find that the average effect that there is an increase in the risk-weighted capital ratio is driven by the more opaque banks (i.e., banks with a low fraction of trading assets on their balance sheets). To achieve a higher risk-weighted capital ratio, these opaque banks rely mostly on adjusting the denominator, i.e., reducing risk-weighted assets. For a treated bank in the 25^{th} percentile of trading assets, the implementation of the FAS 166/167 reforms leads to a 2.75% fall in risk-weighted assets and the effect is statistically significant at the 5% level, while for higher levels of trading assets the effect becomes statistically insignificant and even the sign flips. One concern may be that opaque banks respond more aggressively because they have a higher exposure to the treatment. However, when we explicitly test for this possibility, we find that the cross-sectional differences cannot be explained by the intensity of exposure to the treatment.

Regulators often increase capital requirements even when the higher requirements do not appear to bind given existing buffers. E.g., in January 2022, the German bank regulators, BaFin, raised capital requirements, but they said in a statement,

"Banks will be able to meet this requirement almost entirely from existing excess capital".

In existing papers, banks build up excess buffers to avoid accidentally breaching regulatory requirements due to negative shocks (Berger et al. 1995, Lindquist 2004, Jokipii

& Milne 2008, Stolz & Wedow 2011); thus, raising capital requirements can be effective, even if the increased requirements are not binding, because banks may wish to protect a certain level of buffer. It is suggested that liquidity or fire sale discounts deter banks from selling risky assets to increase their risk-weighted capital ratio when they are arbitrarily close to breaching requirements, thereby necessitating buffer protection. However, it is not clear where these liquidity or fire sale discounts may come from. In this paper, we provide a micro-foundation for these discounts by explicitly considering dynamic information acquisition by banks. In our model, even if the increased requirements are currently slack, opaque banks anticipate that at a future date they may have to sell their assets at an adverse selection discount which may lead to a breach of the regulatory requirements. As a result, they sell assets immediately to avoid this adverse selection discount. Aside from providing theoretical grounding to the existing arguments, our analysis delivers a new empirical prediction which we test and find supporting evidence for.

Additional related literature. Our paper contributes to the literature which studies the impact of bank capital requirements (e.g., Berger & Udell 1994, Laeven & Levine 2009, Behr et al. 2010). In contrast to these studies, we exploit the across-bank heterogeneity in changes in capital requirements, which allows us to make more reliable inferences. In this regard, our paper is closest to Gropp et al. (2019), who we have discussed in detail above. To summarize our novel contribution, we show that there are differences in how transparent and opaque banks deleverage; the latter are more reliant on reducing risk-weighted assets in increasing the risk-weighted capital ratio.

Our paper also adds to a small set of papers which studies the impact of the FAS 166/167 reforms (e.g., Tian & Zhang 2016, Dou et al. 2018, Tang 2019, Dou 2021). These papers focus on the credit supply impacts of the FAS 166/167 reforms, with the general finding that the affected banks cut their credit supply. In contrast, we investigate how affected banks respond to these reforms in terms of their liability structure.

2.2 Model

We present a stylized model of banking which predicts that banks' response to higher capital requirements differs depending on the transparency of their assets. The model has four dates, $t = \{0, 1, 2, 3\}$. There are two types of banks: opaque banks and transparent banks.[1] At $t = 0$, both types of banks have tradeable legacy assets and some non-tradeable assets. Opaque banks own relationship loans while transparent banks own arm's length assets. Only opaque banks expect to acquire private information regarding their tradeable legacy assets over time. A secondary market for assets operates at $t = 0$ and $t = 2$. All agents are risk-neutral and protected by limited liability. The risk-free rate is normalized to 0, so there is no discounting.

It has been argued that bank equity capital is costlier than deposits, which leads to the unregulated bank leverage to be higher than the socially optimal level (see e.g., Allen et al. 2015, Biswas & Koufopoulos 2022). The regulator imposes risk-based capital requirements, i.e., Tier 1 equity capital divided by risk-weighted assets. In addition, breaching the regulatory minimum is assumed to be costly. The cost of breaching the regulatory requirements may be interpreted as higher compliance costs (e.g., an increase in capital charge or restrictions on payout). This implies that a bank will hold a buffer in excess of the capital requirements at $t = 0$. With capital requirement, $k\%$, a bank brings forward a buffer, $b\%$, to $t = 0$, so the risk-weighted capital ratio at this date is $(k + b)$. Banks can sell risky assets which reduces risk-weights and leads to an increase in the risk-weighted capital ratio (similar to Greenwood et al. (2015), Corona et al. (2015) and Dávila & Hébert (2023); see Adrian & Shin (2010) and Shleifer & Vishny (2011), for

[1] In our stylized model, we assume that some banks are transparent, and others are opaque. This assumption may be micro-founded in the framework of Biswas & Koufopoulos (2022), as follows. There are skilled and unskilled banks, and both can divert resources which puts an upper bound on bank leverage. The skilled banks will manage complex (opaque) projects such as relationship loans since they add value to these projects. The unskilled banks manage simpler (transparent) projects. If we assume that more can be diverted from opaque projects then the diversion constraint is more binding for the skilled bankers, and the equilibrium outcome is that opaque banks will be smaller and less levered compared to transparent banks. The details are available upon request.

supporting empirical evidence).

For an opaque bank, the entrepreneur's project has a positive NPV at the time of the loan issuance; the gross interest rate, R, is set such that the bank makes non-negative expected profits, and it is paid at $t = 3$ only if the entrepreneur succeeds, which happens with probability, $p \in (0, 1)$. With the complementary probability, $(1 - p)$, the entrepreneur's project fails, and the loan is not repaid. At $t = 1$ opaque banks privately learn with certainty whether the loan will be repaid or not. For a transparent bank, its tradeable assets will repay R at $t = 3$ with probability p and 0 with probability $(1 - p)$; the difference with opaque banks is that transparent banks do not learn anything about their assets at $t = 1$.

At $t = 2$ both types of banks face a purely idiosyncratic shock with probability $\lambda \in (0, 1)$; there is no aggregate uncertainty and λ is assumed to be distributed independently of p.[2] The shock reduces the value of the non-tradeable assets of the bank which impairs a fraction, $\alpha \in (0, 1)$ of the banks' risk-weighted capital ratio, i.e., if a shock hits a bank, its risk-weighted capital ratio falls from $(k + b)$ to $(1 - \alpha)(k + b)$. The realization of the shock is privately observed by both types of banks. We summarize the timeline of model below:

<u>t=0:</u> Banks own legacy assets with expected value, pR. The bank capital ratio is $k + b$.

<u>t=1:</u> Opaque banks privately learn if the legacy loans will be repaid, whereas transparent banks do not gain any private information.

<u>t=2:</u> Banks face a negative shock to untraded assets with probability, λ. If the shock hits a bank, it impairs a fraction, α, of its risk-weighted capital ratio.

<u>t=3:</u> All returns are realized.

[2]To simplify the analysis, we assume that the idiosyncratic shock hits the banks' untraded assets (this being the only purpose of the untraded assets in our model). However, it should be noted that if the shock hit the traded assets (e.g., lowering the success probability of the legacy assets), the main results go through qualitatively.

We look for the subgame perfect Nash equilibrium of the game and solve it using backward induction. Suppose that at $t = 0$ the risk-weighted capital requirements go up by $\Delta\%$. The increase in requirements is such that the requirements do not bind due to existing excess buffers, i.e., $b > \Delta$. However, if the negative shock hits a bank's untraded assets at $t = 2$, the bank will need to sell risky assets in order not to breach the regulatory requirements. Banks can sell risky assets at $t = 0$ or $t = 2$. Given the increase in risk-weighted capital requirements, if the negative shock hits a bank, the bank will increase risk-weighted capital worth:

$$(k + \Delta) - (1 - \alpha)(k + b) = \Delta + \alpha(k + b) - b \tag{2.2.1}$$

By increasing the amount of capital described in Equation (2.2.1) the bank will ensure that it will not breach the regulatory minimum. How would opaque and transparent banks respond to an increase in risk-based capital requirements at $t = 0$? Consider an opaque bank's problem at $t = 2$. When an opaque bank sells its loans, it is either due to the negative shock to the untraded assets or because it learns at $t = 1$ that the entrepreneur has failed and will not make the loan repayments. The potential buyers of opaque banks' loans do not know the loan quality, although the banks themselves know the loan quality. Therefore, opaque banks sell their bad loans even if they do not experience the negative shock, which leads to an increase in probability of selling loans by opaque banks from λ (the symmetric information prior) to $\lambda + (1 - \lambda)(1 - p)$. Asymmetric information leads to a higher probability that the loans being sold by an opaque bank are bad, compared to the symmetric information prior. If an opaque bank attempts to sell, the fair price of the loan at $t = 2$ will be:

$$\Pi = \frac{\lambda p R}{\lambda + (1 - \lambda)(1 - p)} < pR \tag{2.2.2}$$

In contrast, at $t = 0$ the price of opaque banks' loans is given by pR, which is the fair price of the loan given that the bank does not have superior information about the quality of the loan relative to the outside investors. Note that $pR > \Pi$ for any $\lambda < 1$. This implies that for any feasible parameters, an opaque bank faces an adverse selection discount in selling its loans at $t = 2$, relative to the price at $t = 0$. Lemma 2.1 summarizes the above discussion.

Lemma 2.1. *Opaque banks receive a higher price if selling the loan at $t = 0$ than if selling at $t = 2$. Specifically, the adverse selection discount is $\frac{(1-\lambda)(1-p)}{\lambda+(1-\lambda)(1-p)}pR$.*

Suppose that the shock hits at $t = 2$. Considering the following set of parameters:

$$pR > \Delta + \alpha(k + b) - b > \Pi > \alpha(k + b) - b \qquad (2.2.3)$$

For these parameters, an opaque bank avoids breaching higher capital requirements if it sells its loans at $t = 0$ (first inequality), but not if it sells its loans at $t = 2$ (second inequality). The third inequality ensures that if there is no increase in capital requirements at $t = 0$, opaque bank can meet the regulatory requirements by selling the assets at $t = 2$ implying that if there is no increase in capital requirements the bank can meet any capital shortfall by selling the assets at $t = 2$. If the magnitude of the shock to the untraded assets, α, is more severe (the first inequality flips), selling loans never avoids breaching the regulatory requirements. If the magnitude of the negative shock is less severe (the second inequality flips), the bank avoids breaching regulatory requirements by selling its loans at $t = 2$.

Supposing that α is in the intermediate range (all inequalities in Equation (2.2.3) are satisfied), an opaque bank always sells its loans at $t = 0$. Waiting to sell till $t = 2$ is never an optimal strategy for the opaque bank since with a positive probability there will be a negative shock leading to a breach of the regulatory capital requirements, which is to be avoided in all states given the cost it entails. To ensure that the opaque bank does not fall short of the regulatory requirements in all future states, it responds to an increase in capital requirements by selling its loans, even though the requirements do not bind at $t = 0$.

Lemma 2.2. *For intermediate values of α (given by Equation (2.2.3)), opaque banks sell assets at $t = 0$ in response to an increase in capital requirements at $t = 0$, even if the* *increase in requirements is not immediately binding.*

Next, consider a transparent bank's problem. It does not face the adverse selection problem like opaque banks do. If it sells its assets at $t = 2$, it is clearly because of the shock, and not because it is attempting to hide the sale of bad assets behind the shock. Therefore, its assets are sold at the same price at $t = 2$ as at $t = 0$.

Lemma 2.3. *Transparent banks are indifferent between selling their assets at $t = 0$ or $t = 2$, in response to an increase in capital requirements at $t = 0$.*

To summarize, the key friction in the model is that opaque banks privately learn at the intermediate date whether the loan will be repaid, but the transparent banks do not gain any private information about their assets. In the presence of this friction, opaque banks reduce risk-weighted assets in response to an increase in capital requirements, even if the requirements are not immediately binding; transparent banks are indifferent between selling assets immediately or later. The reason is that in the event of a potential crisis, an opaque bank will face an adverse selection discount in selling its assets such that the proceeds from the sale may not be sufficient to cover the shortfall in equity capital. In contrast, a transparent bank can sell its assets at a fair price at any given point in time. In reality, both types of banks are likely to face some discounts in selling their assets during crisis times (e.g., due to a temporary lower demand for riskier securities during the crisis, as in Shleifer & Vishny 1992, Allen & Carletti 2008, Shleifer & Vishny 2011); the model's predictions are qualitatively unchanged as long as the discount for opaque assets is larger than the discount for transparent assets. The main predictions from the model are stated below:

Empirical Prediction 1. *On average, banks respond to an increase in capital requirements even if the increased requirements are not immediately binding.*

Although, an increase in capital requirements may not lead to a breach in the regulatory requirements due to the presence of excess capital buffers, still it increases the probability that the capital requirements will become binding when a negative shock hits in the future. Because opaque banks acquire private information about their asset quality over time, selling risky assets sooner rather than later reduces the adverse selection cost. For this reason, opaque banks may respond immediately to an increase in capital requirement, even if at this point in time the requirements are not binding. Existing papers suggest that banks build up excess capital buffers to insure against negative shocks leading to a breach of the regulatory requirements (Berger et al. 1995, Lindquist 2004, Jokipii & Milne 2008, Stolz & Wedow 2011). But these papers cannot explain why banks would want to sell risky assets immediately following the increase in capital requirements rather than later, after the negative shock realizes. Our model provides micro-foundations for why selling risky assets following negative shocks can be costly for banks which is that it imposes an adverse selection cost on the bank due to the arrival of private information over time. Thus, banks may sell risky assets following an increase in capital requirements, even though the higher requirements are not immediately binding. The key distinguishing feature of our paper is that it shows whether a bank responds immediately or not to an increase in capital requirements depending on its asset transparency. This allows us to derive a novel empirical prediction, which is the following:

Empirical Prediction 2. *Following an increase in capital requirements, opaque banks reduce leverage more aggressively, relative to transparent banks.*

Opaque banks acquire private information over time which imposes an adverse selection cost on them when they sell risky assets in the event that a negative shock hits the bank. Thus, opaque banks sell risky assets immediately following an increase in capital requirements rather than after the realization of the negative shock. In contrast, transparent banks do not suffer from the adverse selection cost if selling after the negative shock realizes, which makes them indifferent between selling before or after the arrival of information regarding the asset quality since this information is not private.

It is important to note that the predictions rely on an *anticipated* negative shock, which implies that it is not necessary to observe a shock in the data to test the prediction. As long as there is a positive probability of a future shock, transparent and opaque banks respond differentially to an increase in capital requirements. Therefore, to test the predictions, we need an exogenous shock to banks' capital requirements; the FAS 166/167 reforms precisely offer this empirical setting.

2.3 Data and Methodology

2.3.1 Institutional background

Our identification comes from the FAS 166/167 reforms, effective from 2010. Prior to the reforms, banks kept most of the Variable Interest Entities (the VIEs) off their balance sheets, even if retaining exposure to potential losses coming from these assets. Due to being off the balance sheet, the VIEs did not carry a capital charge. The previous standards which governed accounting for securitization, FAS 140 and FIN 46(R), were quantitative in nature, allowing banks to meet the necessary requirements for them to just avoid consolidation (and pay the associated capital charge). Following the FAS 166/167 reforms, banks are required to consolidate all VIEs over which they have significant control, and they retain an obligation to absorb their losses. The new requirements, being qualitative, are less prone to being abused by accounting manipulations.

Starting in 2011, banks disclose the data on the size of assets in consolidated VIEs on Schedule HC-V of the FR Y-9C reports (in 2010 disclosure of this information was not required). We identify 36 banks which reported the consolidation of at least one VIE asset under the FAS 166/167 between 2011- 2015; these 36 banks make up the treatment group. The consolidation of VIE assets leads to an increase in the affected banks' capital charge, which we interpret as a de facto increase in capital requirements.

2.3.2 Data

We use annual bank balance sheet data collected from the FR Y-9C reports of US bank holding companies in the SNL Financial database. Our sample covers 2005–2015, with the implementation of the FAS 166/167 reforms at the beginning of 2010, which falls roughly in the middle of the sample period. To construct the sample, we begin with all 3920 US bank holding companies. We only keep the banks that have non-zero off-balance sheet securitized assets in at least one year during our sample to ensure comparability between the banks affected by the FAS 166/167 and those which were not (see e.g., Casu et al. 2013), who show that securitizing banks differ from non-securitizing banks across several dimensions). We end up with a total of 171 banks in our sample, including the 36 treated banks identified using the VIE consolidation data. Of the 135 control banks, we identify a sub-sample of 62 banks (see Figure 2.1), the smallest of which is larger than the smallest treated bank. We use this set of banks as the final control group. Thus, in the final sample we have 36 treated banks, 62 control banks, and 862 bank-year observations. Including control variables in the regressions reduces the number of observations. To retain the largest sample size possible, we report regressions both with and without including the control variables. We define the main variables in our analysis below, and the summary statistics are in Table 2.1. All continuous variables are winsorized at the 1^{st} and 99^{th} percentiles to avoid the effects of outliers in the regressions.

Under Basel capital adequacy standards, riskier asset categories entail higher risk-weights, implying a higher associated capital charge for them. Therefore, banks may de-leverage by reducing risk-weighted assets (*RWA*) by tilting the asset portfolio away from the riskier assets to the safer ones (e.g., reduce lending and hold cash) and/or by issuing Tier 1 capital (*CET1*), which is composed of core capital including common equity and retained earnings. Unrealized gains and losses on available-for-sale (AFS) securities and loan loss reserves are excluded from Tier 1 capital. We examine how banks deleverage following the implementation of the FAS 166/167 reforms. We hypothesise that banks deleverage primarily through reducing risk-weights, due to costs associated with issuing capital. Therefore, our main dependent variable is *RWA*, scaled by total assets. One concern with this variable is that if consolidated assets have a lower risk-weighting than 100% (e.g., credit card receivables which make up a large portion of consolidated VIEs receive a risk-weighting of 50%), it affects the risk-weighted assets differently from the unweighted total assets. To remove this effect, we remove the consolidated VIEs from both risk-weighted assets and the unweighted total assets to construct *RWA_Adj*. We also test to what extent deleveraging occurs through the numerator, i.e., *CET1*, scaled by total assets. Finally, what is the overall impact of the FAS 166/167 on the risk-weighted capital ratio, *CET1/RWA*.

We control for various bank characteristics in our regressions. Bank size is proxied using the natural logarithm of the total assets, *Size*. *GrowthTA* is the growth rate in *Size*. The return on assets, *ROA*, reflects bank profitability. The average bank in the sample has a *ROA* of 0.871%. *Loan* and *Cash*, which are the ratio of gross loans to the total assets and the ratio of total cash to total assets, reflect the bank's business model and liquidity, respectively. The average bank's loan portfolio makes up 63.52% of its total assets, and it holds 1.98% of the total assets in cash. *Deposit* is the total deposits scaled by the total assets, and *Equity* is the total equity divided by the total assets; together, they reflect the bank's funding structure. The ratio of overheads to the total assets, *Overheads*, captures the bank's operating costs. Finally, we control for the size of the off-balance sheet activities, *OFBS*, by using the total assets securitized divided by the total assets. Off-balance sheet activities make up 4.535% of the bank's total assets.

Bank asset transparency. A key prediction of our model is that the impact of reforms should differ by bank asset transparency. To test the cross-sectional differences across transparent and opaque banks, we interact the average treatment effect with *Trading Assets*, which is the ratio of trading assets to total assets. The idea is that the banks with a high fraction of trading assets can sell these assets at the market price at any given point in time. It may be the case that some trading assets are complex in nature. Transparency in our model is not related complexity, but to the distribution of information about the state of nature which affects the value of the asset. In our model, when we say that an asset is transparent, we mean that market participants have symmetric information about the state of nature, and it is opaque when there is information asymmetry. What is important is not the complexity of the asset as such, but whether banks have private information about their assets. If banks do not have private information about their assets, it is easier for them to sell the assets in the event of a negative shock because they will not face an adverse selection discount. Since trading assets are held as short-term investments, banks which own these assets are unlikely to know more about these assets than outside investors. Furthermore, banks that hold a larger proportion of their assets in trading assets might be categorized as capital markets-oriented banks, contrasting with commercial banks (Roengpitya et al. 2014). Capital markets-oriented banks are likely to have an arm's-length loan portfolio, resulting in less private information about these loans compared to commercial banks, whose loan portfolio mainly consists of relationship loans, giving them access to more private information. On average, banks in our sample have 0.862% of their assets in trading assets. Banks in the treatment group have a higher fraction of their assets in trading assets with the mean being 2.116%, and importantly, there is substantial variation in this variable within the sample of treated banks.

2.3.3 Methodology

We identify the impact of the higher capital requirements on bank deleveraging using a difference-in-differences research design. We estimate the following regression:

$$Y_{i,t} = \beta_1 Post_t * Consolidation_i + \alpha X_{i,t-1} + \gamma_i + \gamma_t + \varepsilon_{i,t} \tag{2.3.1}$$

where $Y_{i,t}$ is the outcome variable (e.g., *RWA*) for bank i in year t. *Consolidation* is an indicator variable that equals one if a bank consolidated VIEs under the FAS166/167 and zero otherwise. *Post* is an indicator variable, which equals one if the year is 2010 or later and zero otherwise. We include the bank fixed effects, γ_i, to control for time-invariant bank characteristics and the year fixed effects, γ_t, to control for time-varying shocks. We cannot estimate the coefficients on *Post* and *Consolidation* because these are subsumed by the included fixed effects. The variable of interest is the interaction term, *Post*Consolidation*, which captures the banks in the treated group in the post-reform period. The vector, X_{it-1}, is the set of bank characteristics (e.g., *Size*, *OFBS*, and others discussed in Section 2.3.2); the controls are lagged by one period to mitigate endogeneity concerns. We estimate Equation (2.3.1) using OLS, and the standard errors are clustered at the bank level.

2.4 Results

2.4.1 Parallel trends

The validity of our difference-in-differences set-up requires that the parallel trend assumption is not violated, i.e., the change in the treated and control banks' outcome variables would have followed a similar trend in the absence of the FAS 166/167 implementation (Angrist & Krueger 1991). In Table 2.2, we look at the evolution of changes in the primary outcome variables, *RWA* and *CET1*, prior to the reforms. Panel (a) reports the results for *RWA*. The difference between the treated and control banks in the change in *RWA* is not statistically different from zero for two of the most recent pre-reform horizons, although the difference becomes positive statistically significant at the 10% level for the longest horizon. This observation suggests that although prior to the global financial crisis, *RWA* evolved differently for our treated and control banks, the trends became parallel over the crisis years, 2007 - 2009, leading up to the FAS 166/167 reforms. In Panel (b), we consider *CET1*; for this variable, the difference is statistically significant in the most recent horizon. These observations suggest that the parallel trends assumption is likely to be satisfied for *RWA*, although not necessarily for

CET1. We present further tests of the parallel trends assumption below.

2.4.2 Baseline results

We examine how banks deleverage following the de facto increase in capital requirements induced by the reforms. Regulatory capital requirements under Basel II are in terms of Tier 1 capital over risk-weighted assets. Higher capital requirements may be met either through increasing Tier 1 capital on the liability side (the numerator) or reducing risk-weights of assets (the denominator).

We begin by visually inspecting how each element of bank leverage evolves around the reforms in Figure 2.2. We plot the means of the primary outcome variables, *RWA* and *CET1*, separately for the treated and control banks. Panel (a) shows that prior to the reforms, i.e., over the crisis years, the mean *RWA* is similar for the two groups. There is an immediate differential impact following the FAS 166/167 reforms, with a much sharper fall for the treated banks compared to the control banks. The visuals in panel (a) are striking: the mechanical impact (i.e., if the treated banks did not respond to the reforms), of consolidating the VIEs on the balance sheet would be higher risk-weighted assets for the treated banks. That we observe the opposite in the data is indicative of a strong response by the treated banks. In panel (b), we plot the mean *CET1* around the reforms for the treated and control groups. In the most recent pre-reform year, the *CET1* variable climbs for both groups, but sharper for the treated banks. Post-reform, there is no discernible differential impact detected in the *CET1* variable. The raw data plots suggest that bank deleverage primarily by reducing the risk-weighted assets following the reforms.

In Table 2.3, we present the regression results. In columns 1 and 2, the dependent variable is *RWA*, and the regressions are without and with controls included, respectively. β_1, which is the coefficient on the interaction term, *Post*Consolidation*, is negative and statistically significant at the 1% level in both columns. In terms of the economic magnitude of the effect, the implementation of the FAS 166/167 reforms leads to a 3.28% fall in risk-weighted assets, on average (after including bank-level controls in the regression). This result suggests that in response to the higher requirements, banks re-balance their portfolio towards assets which have lower risk-weights attached to them. The response is sufficiently strong to overturn the mechanical impact of the reforms which is to increase the amount of risk-weighted assets. The finding is consistent with Dou et al. (2018) who find that the banks affected by the FAS 166/167 reforms reduce mortgage origination and increase the sale of existing mortgages. In columns 3 and 4, the dependent variable is *RWA_Adj*, and the results are qualitatively the same. In columns 5 and 6, the dependent variable is *CET1*, and the regressions are without and with controls included, respectively. The coefficient on the interaction term is statistically insignificant at the conventional levels in both columns, consistent with the raw data plots.

In Figure 2.3, we trace out the dynamic effects of bank de-leveraging by plotting the coefficients obtained from estimating a version of Equation (2.3.1), replacing the interaction term, *Post*Consolidation*, with interactions of *Consolidation* with each year, and the year before the reforms, 2009, serves as the excluded category. In panel (a), we plot *RWA*. The pre-reform coefficients are insignificant, confirming that there are no significant pre-trends, and the post-reform coefficients are negative and statistically significant for several of the years. Note that non-action by treated banks would lead to positive coefficients. Thus, negative but insignificant coefficients (as in the first two treated years) do not suggest that treated banks did not respond; the correct interpretation would be that treated banks responded by reducing *RWA*, but the response only neutralized the mechanical impact of the reforms in these years, it did not overturn it. In contrast, for *CET1* which is plotted in panel (b), the plotted coefficients suggest that in 2009 there is a positive adjustment, but the post-reform coefficients are statistically insignificant. Overall, these results indicate that the average bank meets the increased requirements through adjusting the denominator rather than numerator. Our results are consistent with the findings of Gropp et al. (2019) who also find evidence for bad deleveraging being the predominant response of the average bank to an increase in capital requirements, using a different empirical setting (the EBA capital exercise).

In columns 7 and 8, we estimate Equation (2.3.1) using *CET1/RWA* as the dependent variable, and the regressions are without and with controls included, respectively. The coefficient on the interaction term, *Post*Consolidation*, is positive and statistically significant in both columns. The magnitude of the effect is economically important. The treated banks increase their risk-weighted capital ratio by 1.1% (in the specification which includes the controls), which is roughly 10.1% of the sample average for this variable. This result confirms that the treated banks deleverage in response to the higher capital requirements.

2.4.3 Robustness

Since the post-reform period begins in 2010, one possibility is that global financial crisis of 2007- 2009 drives our results. Alternatively, it may be the case that banks anticipate the reforms (see e.g., Hendricks et al. 2023). Additionally, motivated by the crisis, this period also experienced other major reforms, such as the Dodd-Frank Act and the Basel III (although, the implementation of Basel III did not start till much after the FAS 166/167 reforms and is still not completed in 2022). Our choice of control banks mitigates these concerns to some extent since they are also securitizing banks and comparable in size. We perform two additional tests to further address these concerns and report the results in Tables 2.4 and 2.5.

In Table 2.4, we use the year before the crisis, 2006, as the placebo treatment year (with the sample from 2003-2009)[3]: if the crisis is driving our original findings, then the placebo effect should be significant in the treated banks. We do not find this to be the

[3] Since there is no VIE consolidation during the placebo years, the *RWA_Adj* variable is the same as the *RWA* variable, and hence, excluded from the table.

case for any of our dependent variables, which suggests that the crisis is not driving our findings.

Each of the nine globally systemically important banks, G-SIBs, in the sample is a treated bank. Given that the crisis and the ensuing regulations affected G-SIBs asymmetrically compared to the non-G-SIBs, it is possible that the treatment effect is a G-SIB effect, rather than coming from the FAS 166/167 reforms. To investigate this possibility, we re-do the original regressions, but drop the G-SIBs from the sample (in Table 2.5). The coefficients of interest are identical in sign to the full-sample regressions and remain statistically significant for *RWA*, while insignificant for *CET1*, suggesting that the G-SIBs do not drive our findings.

2.4.4 Cross-sectional heterogeneity

Our model generates a new prediction that the effects of an increase in capital requirements should be stronger for opaque banks. To test the hypothesis, we augment Equation (2.3.1) with *Trading Assets* and its interactions with *Post*, *Consolidation*, and *Post*Consolidation*. Specifically, we estimate the following regression:

$$\begin{aligned} Y_{i,t} =& \beta_1 Post_t * Consolidation_i + \lambda_1 Post_t * Consolidation_i * Trading\ Assets_{i,t-1} \\ &+ \lambda_2 Post_t * Trading\ Assets_{i,t-1} + \lambda_3 Consolidation_i * Trading\ Assets_{i,t-1} \\ &+ \lambda_4 Trading\ Assets_{i,t-1} + \alpha X_{i,t-1} + \gamma_i + \gamma_t + \varepsilon_{i,t} \end{aligned} \tag{2.4.1}$$

The coefficient, λ_1, captures the heterogeneous effect of bank transparency. The sum, $\beta_1 + \lambda_1 * Trading\ Assets$, represents the treatment effect for a given level of *Trading Assets*. The prediction from the model is that λ_1 will take the opposite sign to β_1, when the dependent variable is *RWA*.

In Table 2.6, we estimate Equation (2.4.1). In column 1, the dependent variable is *RWA*. β_1, which is the coefficient on the interaction term, *Post*Consolidation*, is negative and statistically significant at the 5% level, while the coefficient on the triple interaction term, λ_1, is positive, as is predicted. For a treated bank in the 25^{th} percentile of *Trading Assets* (0.09%), the implementation of the FAS 166/167 reforms leads to a 2.75% fall in risk-weighted assets and the effect is statistically significant at the 5% level. For treated banks with higher levels of *Trading Assets*, the sum $\beta_1 + \lambda_1 * Trading\,Assets$ becomes positive. This suggests that the more opaque banks, but not the more transparent banks, reduce risk-weighted assets sufficiently to overturn the mechanical impact of the reforms. In column 2, we obtain similar results when we use the adjusted variant, *RWA_Adj*. The findings are consistent with opaque banks selling riskier assets in order to avoid the adverse selection costs in the potential event of a crisis. In column 3, the dependent variable is *CET1*. The estimates of β_1 and λ_1 are positive and negative, respectively. For treated banks with low levels of *Trading Assets*, the implementation of the FAS 166/167 has a positive effect on *CET1*, but the effect is not statistically significant. For treated banks with higher levels of *Trading Assets*, the sum, $\beta_1 + \lambda_1 * Trading\,Assets$, becomes negative. In column 4, the dependent variable is the risk-weighted capital ratio, *CET1/RWA*. The estimates of β_1 and λ_1 are positive and negative, respectively. The sum, $\beta_1 + \lambda_1 * Trading\,Assets$, is positive and statistically significant for opaque banks (e.g., for a treated bank in the 25^{th} percentile of *Trading Assets*, the implementation of the FAS 166/167 reforms leads to a 0.91% increase in *CET1/RWA*) but for higher levels of transparency, the effect becomes statistically insignificant and the sign flips.

Overall, the evidence in Table 2.6 suggests that the average effect that there is an increase in the risk-weighted capital ratio in response to the reforms by the treated banks is driven by the more opaque banks. To achieve a higher risk-weighted capital ratio, these opaque banks rely mostly on adjusting the denominator, i.e., reducing risk-weighted assets, and less so on adjusting the numerator, i.e., increasing the Tier 1 capital (the effect on the numerator is statistically insignificant). The findings are consistent with Empirical Prediction 2 which states that opaque banks respond more aggressively to a change in capital requirements due to dynamic considerations.

One possibility is that the heterogeneity results arise from transparent banks being systematically differently exposed to the reforms, which then leads to a different treatment effect for transparent banks compared to opaque banks; specifically, the concern is that opaque banks may be more exposed to the treatment which results in a stronger response by them to the treatment. To address this concern, we construct an exposure measure and explicitly test to what extent the treatment exposure can explain our heterogeneity findings in Table 2.6. We calculate the mean VIE for each treated bank, and create an indicator variable, *Intensity*, which takes the value, 1, if the mean VIE for a bank is above the 75^{th} percentile of treated banks, and 0, otherwise.[4]

In Table 2.7 we estimate an augmented version of Equation (2.4.1) which includes the interaction of *Intensity* with the treatment effect, *Post*Consolidation*. The associated interaction terms - *Post*Intensity* and *Consolidation*Intensity* - are subsumed due to perfect collinearity. For *RWA* and *CET1*, the triple interaction term, *Post*Consolidation*Intensity*, enters with the opposite sign to β_1, but insignificantly. This implies that a higher intensity of exposure to the treatment paradoxically weakens the treatment effect, although the effect is statistically insignificant. That the sign on the triple interaction term is opposite to expectation is likely because opaque banks are exposed to the treatment with a lower intensity. For *CET1/RWA*, the triple interaction term enters with the same sign as β_1, but it is statistically insignificant. Importantly for us, the key findings from the previous table - the more opaque banks, but not the more transparent banks, increase their risk-weighted capital ratio in response to the reforms, and do so through reducing risk-weighted assets - are robust to controlling for the response of the treated banks varying by the treatment intensity.

[4] We obtain similar results using 50^{th} percentile as the cut-off to define the *Intensity* variable.

2.5 Conclusion

We examine how banks deleverage in response to higher capital requirements. After the implementation of the FAS 166/167 in 2010, banks were required to consolidate the securitized VIEs onto their balance sheets. The consolidation itself did not directly affect the banks' risk exposures. Since the consolidated assets were included in the risk-weighted assets, the treated banks experience a (de facto) increase in capital requirements. We identify 36 banks which consolidated at least one VIE asset during 2011-15, which make up the treated group, and 62 securitizing banks which are comparable in size to the treated banks make up the control group.

We find that, on average, banks de-lever by reducing risk-weights. The average effect is driven by the more opaque banks. To explain our findings, we present a model in which banks with opaque assets may suffer adverse selection discounts in selling their assets in the potential event of a crisis - by selling risky assets before they acquire private information about them, opaque banks avoid the adverse selection discount. Our findings provide a rationale for why (some) banks respond to an increase in capital requirements, even when the requirements do not immediately bind.

Figure 2.1. **Bank size distribution.**

This graph shows the size distribution of the control and treated groups. The Y-axis is the log of size. The value, 0, on the X-axis denotes the controls banks, while the value, 1, denotes the treated banks.

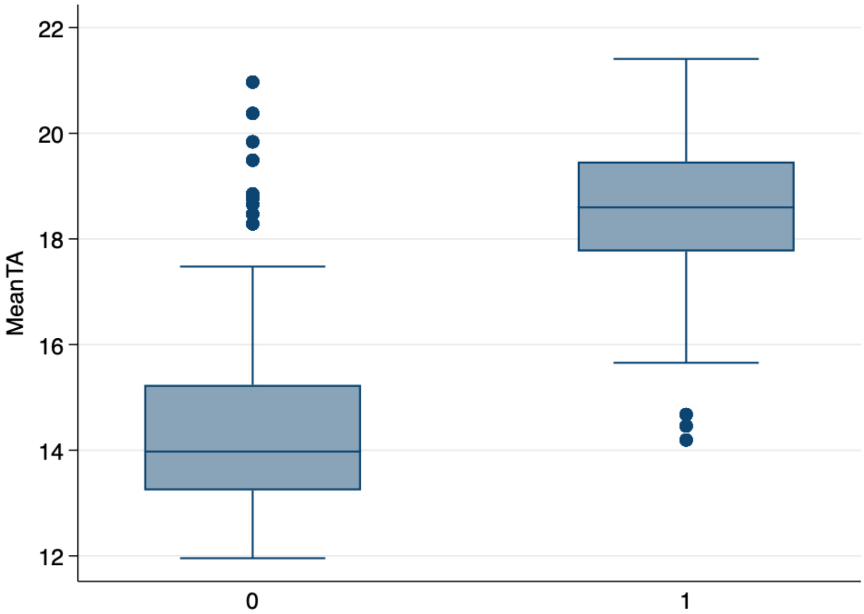
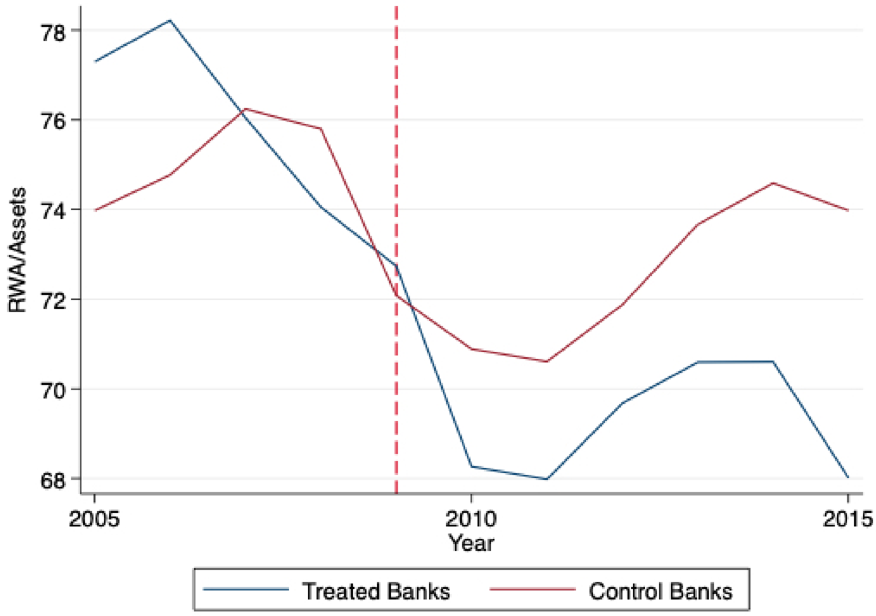
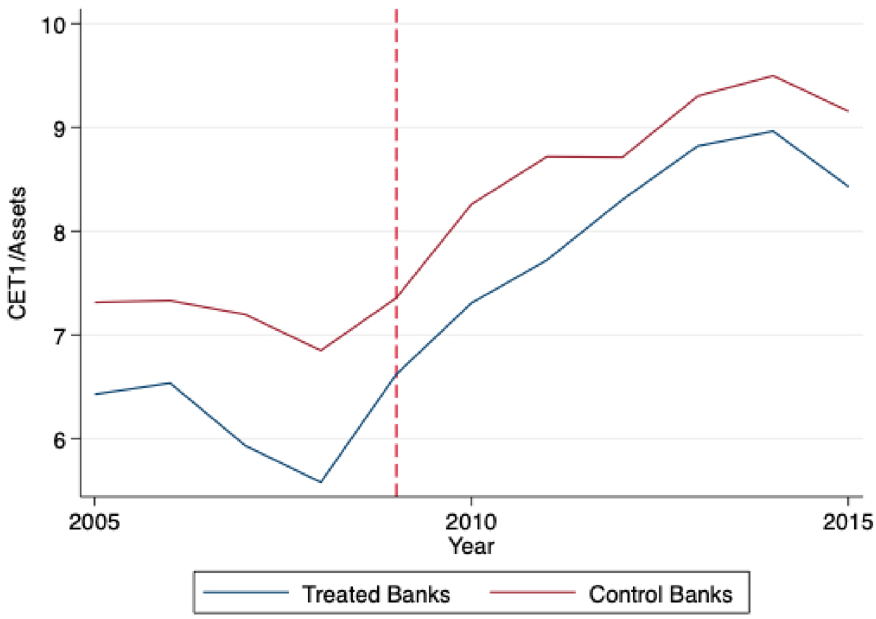


Figure 2.2. **Unconditional average effects.**

This figure plots the means of the outcome variables, *RWA/Assets* and *CET1/Assets*, separately for the treated and control groups over the sample period. The treatment date is the start of 2010.



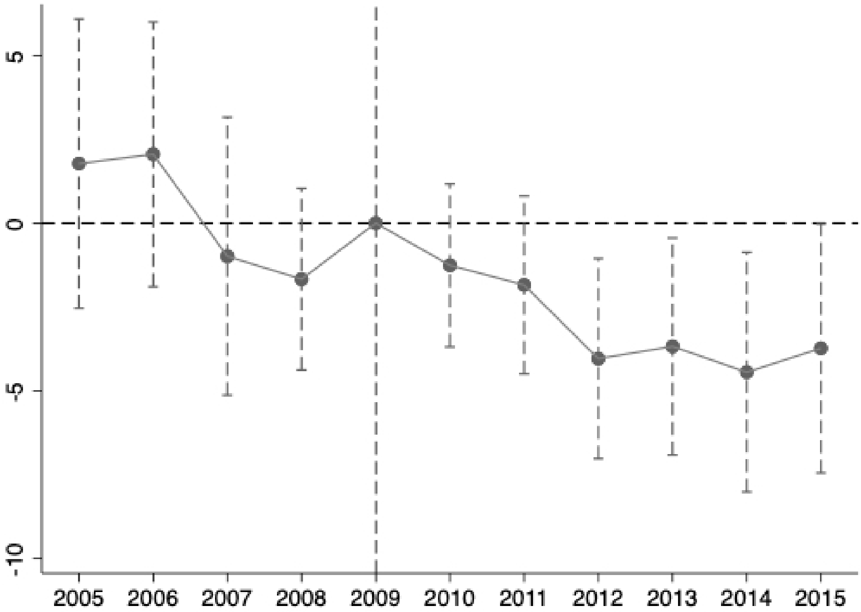
Panel (a): RWA/Assets



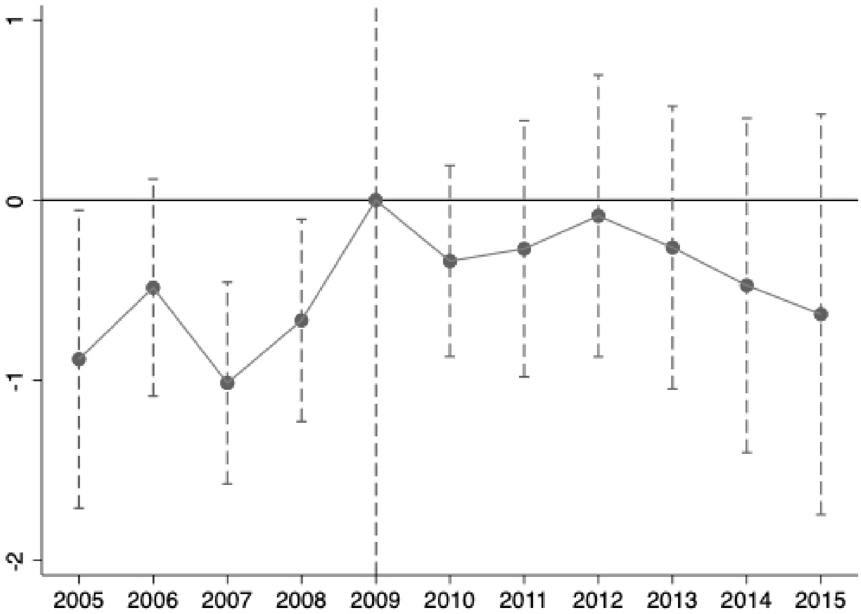
Panel (b): CET1/Assets

Figure 2.3. **Dynamic effects of bank de-leveraging.**

This figure plots the dynamic effects of bank de-leveraging. In particular, this figure plots the coefficient estimates of an augmented version of Equation (2.3.1), replacing the interaction term, *Post*Consolidation*, with the interactions of *Consolidation* with a set of year dummy variables. We exclude the year before the reforms, 2009, thus estimating the dynamic effect of the reforms relative to that year. Vertical bars indicate 95% confidence intervals based on standard errors clustered at the bank level.



Panel (a): RWA/Assets



Panel (b): CET1/Assets

Table 2.1. **Descriptive statistics.**

The table shows the summary statistics of the key variables used in the analysis (see Section 2.3.2). All variables are winsorized at the 1^{st} and 99^{th} percentiles to minimize the effects of outliers.

Variable	N.	Mean	SD	p10	p25	p50	p75	p90
RWA/Assets	862	72.876	14.164	53.332	66.180	74.931	82.022	88.014
RWA_Adj	862	72.688	14.208	53.182	66.180	74.683	81.578	88.011
CET1/Assets	853	7.898	4.560	4.258	5.616	7.468	8.950	10.534
CET1/RWA	860	11.106	5.516	6.165	7.980	10.495	12.535	15.480
Size	897	16.499	1.817	14.410	14.825	16.074	18.301	19.429
GrowthTA	876	6.969	14.279	-3.843	0	4.241	9.885	18.867
Trading Assets	847	0.862	1.787	0	0	0	0.546	4.113
ROA	880	0.871	0.861	0.005	0.600	0.950	1.225	1.550
Loan	886	63.521	15.620	37.330	59.140	67.255	73.840	78.730
Cash	886	1.982	1.083	0.870	1.260	1.775	2.450	3.370
Deposits	887	69.854	14.317	44.070	64.720	74.210	80.000	83.770
Equity	885	10.510	3.369	6.990	8.440	10.070	12.070	14.400
Overheads	880	3.339	1.294	2.250	2.660	3.040	3.585	4.740
OFBS	887	4.535	21.834	0	0	0	3.078	10.842

Table 2.2. **The evolution of changes in the outcome variables for the pre-treatment years.**

The table reports the changes in *RWA/Assets* and *CET1/Assets* for different horizons prior to the reforms. Columns 1 and 2 show the evolution of changes in the treated and control groups, respectively. Column 3 reports the differences in the changes between the two groups, and the t-statistic testing the equality of means is reported in column 4.

	(1) Treated	(2) Control	(3) Differences	(4) T-Statistic
Panel a. RWA/Assets				
2009-2008	-2.130	-3.765	-1.635	-1.111
2009-2007	-4.123	-3.821	0.303	0.141
2009-2006	-6.295	-2.349	3.946*	1.724
Panel b. CET1/Assets				
2009-2008	0.817	0.268	-0.549**	-2.328
2009-2007	0.464	-0.002	-0.466	-1.410
2009-2006	-0.139	-0.122	0.017	0.046

Table 2.3. **Unconditional response to higher capital requirements.**

In columns 1 and 2, the dependent variable is *RWA/Assets*, in columns 3 and 4 it is *RWA_Adj*, in columns 5 and 6, it is *CET1/Assets*, and in columns 7 and 8, it is *CET1/RWA*. *Consolidation* is an indicator variable that equals one if banks consolidated VIEs under the FAS 166/167. *Post* is an indicator variable that equals one after the implementation of the FAS 166/167. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	RWA/Assets		RWA_Adj		CET1/Assets		CET1/RWA	
Post*Consolidation	-5.138***	-3.277***	-5.886***	-3.924***	-0.072	0.270	0.947*	1.123**
	(-3.20)	(-2.77)	(-3.67)	(-3.35)	(-0.18)	(0.89)	(1.76)	(2.33)
Size		1.377		1.551		-1.818***		-2.554***
		(0.89)		(1.00)		(-4.34)		(-3.34)
GrowthTA		-0.039***		-0.041***		-0.006		-0.002
		(-2.96)		(-3.08)		(-1.56)		(-0.30)
ROA		-0.039		-0.026		0.344***		0.521**
		(-0.08)		(-0.05)		(2.72)		(2.59)
Loan		0.599***		0.590***		0.020		-0.058
		(13.00)		(12.69)		(1.08)		(-1.59)
Cash		0.336		0.275		-0.024		-0.154
		(1.15)		(0.95)		(-0.21)		(-0.71)
Deposit		-0.053		-0.040		0.012		0.019
		(-1.01)		(-0.76)		(0.52)		(0.42)
Equity		-0.104		-0.087				
		(-0.53)		(-0.45)				
Overheads		0.112		0.188		0.183*		0.159
		(0.43)		(0.69)		(1.80)		(1.04)
OFBS		0.124		0.143*		0.050***		0.031
		(1.64)		(1.83)		(3.20)		(1.42)
Observations	862	834	862	834	853	826	860	831
R^2	0.202	0.480	0.221	0.490	0.309	0.433	0.349	0.439
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2.4. **Robustness tests by using the placebo treatment year, 2006.**

In this table, we report the results of placebo tests using the sample period during 2003-2009. In column 1 the dependent variable is *RWA/Assets*, in column 2 it is *CET1/Assets*, and in column 3 it is *CET1/RWA*. *Consolidation* is an indicator variable that equals one if banks consolidated VIEs under the FAS 166/167. *Post* is an indicator variable that equals one after 2006 (i.e. the year preceding the crisis). Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) RWA/Assets	(2) CET1/Assets	(3) CET1/RWA
Post*Consolidation	-1.053	0.190	0.602
	(-0.96)	(0.59)	(1.50)
Controls	Yes	Yes	Yes
Observations	506	503	503
R^2	0.335	0.127	0.153
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Table 2.5. **Robustness tests after dropping the G-SIBs.**

In this table, we report the results without the nine G-SIBs. In column 1 the dependent variable is *RWA/Assets*, in column 2 it is *RWA_Adj*, in column 3 it is *CET1/Assets*, and in column 4 it is *CET1/RWA*. *Consolidation* is an indicator variable that equals one if banks consolidated VIEs under the FAS 166/167. *Post* is an indicator variable that equals one after the implementation of the FAS 166/167. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) RWA/Assets	(2) RWA_Adj	(3) CET1/Assets	(4) CET1/RWA
Post*Consolidation	-2.733***	-3.175***	0.364	1.117**
	(-2.76)	(-3.20)	(1.03)	(2.01)
Controls	Yes	Yes	Yes	Yes
Observations	753	753	745	745
R^2	0.465	0.470	0.428	0.429
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 2.6. **Trading assets and response to higher capital requirements.**

In column 1 the dependent variable is *RWA/Assets*, in column 2 it is *RWA_Adj*, in column 3 it is *CET1/Assets*, and in column 4 it is *CET1/RWA*. *Consolidation* is an indicator variable that equals one if banks consolidated VIEs under the FAS 166/167. *Post* is an indicator variable that equals one after the implementation of the FAS 166/167. The interactions with *Trading Assets* are included. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) RWA/Assets	(2) RWA_Adj	(3) CET1/Assets	(4) CET1/RWA
Post*Consolidation, β_1	-2.892**	-3.279***	0.405	1.010**
	(-2.51)	(-2.86)	(1.11)	(2.12)
Post*Consolidation**Trading Assets*, λ_1	1.636	1.555	-0.762	-1.112
	(0.78)	(0.73)	(-1.66)	(-1.25)
Post*Trading Assets	-1.480	-1.530	0.790*	1.184
	(-0.72)	(-0.74)	(1.76)	(1.36)
Consolidation*Trading Assets	-1.467	-1.295	0.291	0.152
	(-0.63)	(-0.55)	(0.57)	(0.15)
Trading Assets	2.796	2.816	-0.430	-0.898
	(1.24)	(1.24)	(-0.91)	(-1.12)
$\beta_1+\lambda_1*25^{th}$ pct Trading Assets	-2.745**	-3.140***	0.336	0.910**
	(-2.45)	(-2.81)	(0.96)	(1.99)
$\beta_1+\lambda_1*75^{th}$ pct Trading Assets	4.049	3.321	-2.828	-3.711
	(0.47)	(0.38)	(-1.54)	(-1.02)
Controls	Yes	Yes	Yes	Yes
Observations	796	796	788	793
R^2	0.492	0.502	0.437	0.463
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 2.7. **Controlling for the treatment intensity.**

In column 1 the dependent variable is *RWA/Assets*, in column 2 it is *RWA_Adj*, in column 3 it is CET1/Assets, and in column 4 it is *CET1/RWA*. *Consolidation* is an indicator variable that equals one if banks consolidated VIEs under the FAS 166/167. *Post* is an indicator variable that equals one after the implementation of the FAS 166/167. The interactions with *Trading Assets* and *Intensity* are included. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) RWA/Assets	(2) RWA_Adj	(3) CET1/Assets	(4) CET1/RWA
Post*Consolidation, β_1	-2.895**	-3.277***	0.406	1.009**
	(-2.53)	(-2.85)	(1.15)	(2.11)
Post*Consolidation*Trading Assets, λ_1	1.526	1.676	-0.694	-1.142
	(0.72)	(0.78)	(-1.44)	(-1.26)
Post*Trading Assets	-1.472	-1.539	0.782*	1.188
	(-0.72)	(-0.74)	(1.73)	(1.37)
Consolidation*Trading Assets	-1.492	-1.268	0.306	0.146
	(-0.64)	(-0.54)	(0.60)	(0.14)
Post*Consolidation*Intensity	1.015	-1.115	-0.611	0.269
	(0.59)	(-0.67)	(-0.74)	(0.26)
Trading Assets	2.788	2.825	-0.424	-0.901
	(1.24)	(1.24)	(-0.89)	(-1.12)
β_1+λ_1*25^{th} pct Trading Assets	-2.757**	-3.126***	0.343	0.907*
	(-2.48)	(-2.79)	(1.02)	(1.98)
β_1+λ_1*75^{th} pct Trading Assets	3.579	3.837	-2.541	-3.837
	(0.41)	(0.43)	(-1.31)	(-1.04)
Controls	Yes	Yes	Yes	Yes
Observations	796	796	788	793
R^2	0.492	0.502	0.439	0.463
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Chapter 3

Creditor participation and democracy on the cost of credit in the global syndicated loan market

3.1 Introduction

Banks are the most prominent providers of external finance for firms across the world. When making a lending decision, banks would evaluate not only the credit quality and the riskiness of a borrower itself but also the political system and the law environment of the borrower's country. The extent of political development and legal protection in a country are important factors in shaping the impact of the financial system on the real economy and determining the loan contract terms, such as loan price, maturity, collateral, and volume, et al. Creditor protection is important in determining loan contract terms since the level of creditor protection affects the insolvency process in the event of a borrower's default. Under greater creditor protection, banks would provide better loan contract terms (e.g., lower loan spreads, longer maturity, etc.) as they have more bargaining power to force repayment and control the insolvency process and therefore can anticipate higher recovery rates in the event of default. A bunch of literature examines the effect of creditor protection on loan terms (e.g., Qian & Strahan 2007, Bae & Goyal 2009, Haselmann et al. 2010). They find that credit can benefit more as creditor protection increases. At the same time, the quality of democratic institutions affects the stability of a country, and thus further affects the development of economics. It has been argued that democracy improves economic growth and creates more well-developed markets, such as markets with better regulation and social welfare (Acemoglu et al. 2019). The GDP per capita is also typically higher when countries are at a higher level of democracy (Papaioannou & Siourounis 2008, Acemoglu et al. 2019). Moreover, in democratic countries, there is better information transparency, especially between lenders and borrowers, which thereby benefits the credit supply. There is an emerging literature which studies the effects of democracy on loan terms and points out that democracy can affect economic development by reducing the cost of credit (Delis et al. 2020, Osei-Tutu & Weill 2020). Nevertheless, how the interaction between the level of democracy and creditor protection affects the loan contract terms remains unclear. In this chapter, we explore how the cost of credit is affected by the interaction of changes in creditor participation rights and democracy.

This interaction impact of creditor participation rights and democracy on loan spreads is especially difficult to empirically explore since creditor protection and democracy are likely to be correlated (Olson 2000, Arner et al. 2017). Many researchers have argued that the democracy of governance is optimal for providing legal protection and forcing the enforcement of contracts (Arner et al. 2017). Therefore, we use a plausibly exogenous change in the creditor participation index to separately examine how an increase in creditor participation rights affects loan spreads in the high democratic and the low democratic (hence, more autocratic) countries.

This chapter investigates the creditor protection-cost of credit relationship in countries with different levels of democratic development. Using the staggered changes of creditor participation index across countries, we examine whether the effect of stronger creditor protection on the cost of credit differs depending on the democracy level (i.e., democratic versus autocratic countries). We find that the increase in creditor participation rights only declines the cost of credit in the low democratic countries. In the high democratic countries, the effect of an increase in creditor participation rights on loan spreads is statistically insignificant in most specifications. The policy implications are potentially large: in the relative autocratic countries, a higher creditor participation right can ease credit access and benefit loan spreads. However, similar creditor protection will be less effective in the high democratic countries. This implies that creditor protection is more valuable at lower levels of democracy.

Conceptually, investigating the interaction effects of democracy and creditor participation rights is meaningful. Both higher levels of democracy and creditor protection lead to a lower loan spread. We conjecture that higher democracy or creditor participation rights have a bigger negative impact on the loan spread, which is closer to a higher cost of credit than one that is already at a lower cost of credit. We expect that at lower levels of democracy, the impact of an increase in creditor participation rights on reducing loan spreads is bigger than at higher levels of democracy. We call this effect as the substitution effect.

In this chapter, we provide empirical evidence using the staggered increases of creditor participation rights in seven countries between 2004 and 2014 (i.e., treatment countries). We use the Polity IV country-year measure for the institutional democracy level to label a treatment country as a high (resp. low) democracy country if the mean value of *Democracy* for this country is above (resp. below) the median. Within the treatment countries, we identify four as the high democratic countries, and three as the low democratic countries. We examine the impact of a stronger creditor participation right on the cost of credit for each sub-sample (i.e., democratic or autocratic countries), respectively, and find that the increased creditor participation rights reduce the loan spreads only in the low democratic countries .

We use the loan-level data from the global syndicated loan market that includes loan facilities to firms across countries. The syndicated loan is an arrangement whereby two or more lenders jointly provide lending to a single borrower, has raised increasing attention in recent years, and provides detailed information on the loan facilities, such as the loan interest rates, the loan amount, et al. The cost of credit (loan spreads over the LIBOR plus any annual fees), *AISD*, is the main variable we used to test our hypothesis that stronger creditor protection reduces the cost of credit in low democratic countries only. Then, we match these loan facilities with the borrowers' accounting information obtained from Compustat and a set of macroeconomic variables of a country where the borrower operates from several different public macroeconomic databases. By including a set of loan-level, firm-level, and borrower's country-level variables that are likely to affect loan pricing through variation in the economic development of a country or loan demand, we can focus on the interaction impact of creditor protection and democracy. The summary statistics for the loan-level, borrower-level, and borrowers' country-level data are reported in Table 3.2.

We introduce the staggered difference-in-differences (DID) technique in this chapter. Researchers usually use the general two-way fixed effects (TWFE) DID regressions (Baker et al. 2022) to estimate causal effects. However, when the staggered treatment time exists, the coefficients from the standard TWFE DID models would be biased since the TWFE estimates for one relative-time period are contaminated by the causal effects of other relative-time periods (Callaway & Sant'Anna 2021, Sun & Abraham 2021, Roth et al. 2023). We therefore use two approaches which are robust to the stagged treatment timing: the imputation approach of Borusyak et al. (2021) and the two-stage difference-in-differences approach proposed by Gardner (2022) - to address the potential biased estimates. The main finding in this chapter highlights the substitution effect between democracy and creditor participation rights. An increase in creditor participation leads to a lower loan spread in the low democratic countries, while in the high democratic countries, an increase in creditor participation does not reduce the loan spreads. Economically, the magnitude of the effect is large: in all regressions, the coefficients on the effect of an increase in creditor participation on reducing loan spreads range between 22 and 74 basis points - depending on the specifications, which accounts between 12.7% and 42.8% of the mean spread in the sample.

One concern regarding the potential endogeneity is the creditor participation rights change itself. If the passage of the creditor protection changes is not exogenous and correlated with some country-specific characteristics, it will confound our results. We take several ways to alleviate the endogeneity concerns coming from the changes in creditor participation rights. First, all our specifications include country and year fixed effects that capture time-invariant country characteristics and time-varying shocks to control for all differences between the treated and control countries. Second, we construct a subset of the matched non-treated countries using a propensity-score-based matching technique. The full and matched control groups are both used to examine the substitution effect that we are interested in. Finally, the parallel trends test is satisfied, which indicates that the pre-treatment differences between the treated and control countries are purely random.

3.2 Literature review

The chapter contributes to three principal strands of the literature: the impact of political regimes on the economy literature, the law and finance literature, and the determinants of loan prices literature.

The first strand consists of studies that explore the impact of democracy. The effects of democratization on economic development have been explored by a substantial amount of literature (e.g., Acemoglu et al. 2019, Delis et al. 2020, et al.). A bulk of papers support that the development of democracy has a significant positive impact on economic development (see, Papaioannou & Siourounis 2008, Acemoglu et al. 2019, Delis et al. 2020, et al.). Acemoglu et al. (2019) provide evidence that after controlling the dynamics of GDP in the fixed-effects regression, a permanent democracy leads to an increase in future GDP per capita at a statistically significant level. Along the same lines, Papaioannou & Siourounis (2008) reveal that democracy positively affects the real annual GDP per capita.

There is emerging literature focusing on the impact of democratization on the loan contract terms, which is closer to our paper. Delis et al. (2020) provide empirical evidence that democratization negatively affects the cost of credit by investigating a cross-country sample of syndicated loans in 80 countries between 1984 and 2014. They state that the lower cost of credit is an important benefit of democratic quality on firms, which then transfers the benefit to the real economy through higher investment spending. Similarly, Osei-Tutu & Weill (2020) claim that greater democracy sends a positive signal to banks, which makes firms in democratic countries access credit in a favourable way. We contribute to the literature by showing that higher creditor participation rights mitigate the impact of higher democracy on reducing loan spreads. The key difference between our findings and extant literature is that we explicitly consider the interaction effect of democracy and creditor participation rights on loan spreads. In addition, we use the exogenous changes in creditor participation, which allows us to explore specifically the interaction impact of increased creditor participation and democracy on loan spreads with indicating the direction of causality.

Parallelly, our paper also relates to a vast amount of literature on law and finance, particular in terms of the impact of creditor rights. The growing body of literature on the law and finance shows that creditor rights significantly affect the development of financial systems and corporate strategies. La Porta et al. (1998) point out that creditor rights entitle the creditor to the power to repossess collateral in the event of default. Without these rights, creditors would not be able to get payments when borrowers default, so it would be more difficult for firms to access external finance. They reveal that the lack of creditor protection appears too detrimental to the financial development and growth.

Djankov et al. (2007) construct an index to measure the legal rights of secured creditors for 129 countries based on the works of La Porta et al. (1997, 1998) for every year during their sample period 1978-2003. They state that creditor rights are relatively more important for private credit in the richer countries, while information sharing is more important in the poorer countries. Jayaraman & Thakor (2014) employ changes in the creditor rights index from Djankov et al. (2007) to examine how changes in creditor rights affect a bank's incentive to monitor its borrowers, which further induces a bank to tilt its capital more to equity or debt. In contrast to their study, we emphasise the interaction effect of stronger creditor protection and democracy, rather than the stand-alone impact of higher creditor protection.

A set of papers investigate the relationship between creditor protection and stability. For example, Acharya et al. (2011) and Houston et al. (2010) both examine the relationship between creditor rights and risk-taking, but their results are in opposite directions. Acharya et al. (2011) empirically find that greater creditor rights reduce corporate risk-taking. Houston et al. (2010) find that greater creditor rights lead to an increase in risk-taking. Biswas (2019) also investigates the effects of creditor rights on bank stability. He provides statistically weak evidence that stronger creditor rights lead to a reduction in bank risk-taking. More importantly, he considers the interaction impact of creditor rights and market power on bank stability, examines how creditor rights affect the bank market power-stability relationship by using the staggered passage of legal reforms in 13 countries over the sample period of 1995-2004, and finds that an increase (decrease) in creditor rights declines (increases) the positive impact of market power on bank stability.

More closely to us, Qian & Strahan (2007), Bae & Goyal (2009), and Houston et al. (2010), etc. investigate how creditor rights affect loan spreads. Their findings reveal that with stronger creditor protection, lenders have more incentives to provide lower loan spreads to borrowers. Consistent with the law and finance literature, lenders with greater creditor protection are more likely to provide credit to borrowers with favourable terms as lenders know that they would have higher recovery rates in the event of bankruptcy. Similarly, we find that a greater creditor participation right reduces loan spreads, which is in line with their findings. However, the key difference between our finding and theirs is that our finding only exists when countries where borrowers operate are relatively autocratic, suggesting that creditor protection is more valuable in the autocratic countries.

There are several papers focusing on how creditor rights affect other loan contract structures except for loan prices, such as the loan amount, collateral, and maturity, et al. They generally argue that different creditor protection levels significantly affect the loan contract terms. For example, Esty & Megginson (2003) study the relationship among creditor rights protection, legal enforcement and the syndicated loan composition using project finance loans in 61 countries, and find that lenders tend to create a more concentrated syndicated facility with stronger creditor rights and reliable law enforcement. Miller & Reisel (2012) find that there are more restrictive bond covenants when the country-level creditor rights are weaker. Haselmann et al. (2010) provide evidence that an increase in creditor rights indeed promotes the volume of lending by focusing on 12 legal reform transitions from 1995 to 2002. They further state that stronger creditor rights are more beneficial for individual customers and smaller borrowers than larger firms.

In contrast to the above, we examine whether and how the effect of a higher creditor participation right on the cost of credit differs depending on the different level of democracy. This interaction effect of creditor protection and democracy on the cost of credit has so far been unexplored in the extant literature.

Third, the chapter also contributes to a set of literature on the determinants of loan pricing (e.g., Ivashina 2009, Hasan et al. 2012, 2014, et al.). Ivashina (2009) studies how the lead bank's share in a syndicated loan affects the asymmetric information between the lead and member banks, further affecting the cost of loans significantly. They find that a 9% increase in the lead bank's share decreases the loan spreads required by other participants by approximately 29 basis points. Gorton & Pennacchi (1995) also investigate the impact of lead bank shares on loan prices. However, the economic effect they find is insignificant. Hasan et al. (2012) use US bank loan contract data to analyze the relationship between the predictable earnings of firms and loan contract terms. They provide strong empirical evidence that banks are more likely to provide favourable loan contract terms to firms with predictable earnings, such as lower interest rates, longer maturities, and less strict covenants and collateral requirements. In another study, Hasan et al. (2014) find that firms with greater tax avoidance face stricter loan contract terms, such as higher loan spreads and more stringent collateral and covenant requirements, because corporate tax avoidance activities are considered to have higher risks. None of these works explores how the loan price is affected by an interaction between creditor protection and democracy, which is highlighted in our paper.

3.3 Hypothesis development - Substitution effect

In the substitution effect, I consider how the impact of an increase in creditor participation rights on the cost of credit differs depending on the different level of democracy. In order to derive this relationship, first note that both the higher creditor participation rights and higher democracy level reduce the loan spreads. Countries with stronger legal protection and better political systems are more likely to create an increased size and scope of financial markets, which in turn provide better loan contract terms.

An increase in creditor protection is reported to reduce the loan spreads since higher creditor protection means a higher recovery rate in the event of borrowers' default (see, Qian & Strahan 2007, Bae & Goyal 2009). Under greater creditor protection, creditors are empowered to affect the reorganization and liquidation processes in case of bankruptcy, which means they know that they will be able to take assets from borrowers in the event of default. If the creditor protection is weak, lenders would require additional compensation by higher loan spreads. Additionally, with greater creditor participation rights, there are more creditors that would like to participate in the markets to provide loans, which means there is higher competition among lenders in loan markets. The more loans provided suggest that borrowers are more likely to access loans with a favourable price. At the same time, the empirical finding that a high democratic level decreases loan spreads is increasingly documented (e.g., Delis et al. 2020, Osei-Tutu & Weill 2020). Theoretically, there are two main reasons revealing that democratic development could benefit loan spreads. The extant literature proposes a democratic advantage hypothesis that democracy can provide a better economic development condition. They argue the role of a multi-party election system and the formation of effective checks and balances in democracy, which affect the market perceptions through effective governance and the protection of property rights, and thus create a well-developed market, and an environment of liberalization policies and political stability. In addition, unlike autocracies, democracy is a political regime that provides a more free information flow and better civil liberty protection. Information flows more freely in democratic countries that can alleviate asymmetric information to some extent. Reducing asymmetric information, especially between lenders and borrowers, can benefit the lending supply terms. Therefore, the loan spreads would be lower when the level of democracy is higher.

Both creditor protection and democracy levels affect the loan spreads negatively. I conjecture that this relationship is concave. This implies that democracy or creditor participation rights have a decreasing impact on loan spreads. Higher democracy or increased creditor participation rights have a bigger negative impact on the loan spread that is closer to a higher level of credit cost than one that is already at a lower cost of credit.

At a lower level of democracy, when the cost of credit is higher, the reduction effect of an increase in creditor participation rights on the cost of credit is bigger than at a higher level of democracy, when the cost of credit is lower. The loan spreads in the low democratic country are higher, and hence benefit more from greater creditor participation rights than the loan spreads in the high democratic country and are already low. Therefore, we expect that the effect of an increased creditor participation right on declining loan spreads in autocratic countries is bigger than in democratic countries. Creditor participation rights are more valuable in autocratic countries. I state the null hypothesis formally as follows:

Hypothesis 1: The impact of creditor participation on loan spreads differs depending on the level of democracy. The impact of an increase in creditor participation on reducing loan spreads is bigger in the lower democracy countries than in the higher democracy countries. Democracy and creditor participation are substitutes.

3.4 Data and Methodology

3.4.1 Sample

We compile the data from several sources. The loan-level data come from the Loan Pricing Corporation (LPC) DealScan database which includes the most comprehensive and historical loan-deal information, such as the loan interest rates, the loan maturity, whether the loan is secured or not, and the number of lenders in a syndicate, et al., for public firms available on global syndicated loan markets. Syndicated loans are the dominant way for large corporations to get external financing from banks and other financial institutions. A syndicated loan is a form of loan in which two or more lenders jointly provide funds to a specific borrower. It generally arises when a project needs too much funding to be met by a single lender. In each loan facility, there are typically one or more lead arrangers who establish a relationship with the borrower firms and negotiate the details of the loan contract terms on behalf of the other lenders, and the other lenders are participants. Specifically, the lead bank(s) meets with the borrower to collect soft information, assess the loan quality, negotiate the loan contract terms, and draft an information memorandum for participant banks. The loan terms and conditions are similar for all syndicate participants. The borrower would pay the lead bank(s) a management fee, which is usually a percentage of the loan amount. The main purposes of syndicated loans are to spread the risks of a borrower default across multiple lenders and share financial opportunities. Simons (1993) argues that diversification is the major reason behind syndicated loans.

Firm-level accounting information is obtained from the Compustat database and merged with the loans in the DealScan database using the Compustat-DealScan link file provided by Chava & Roberts (2008), which would generate a richer set of financial variables. Macroeconomic variables come from different publicly available sources, e.g., Polity IV Project and World Development Indicators (WDI). We provide a summary of variable definitions and sources in Table 3.1.

Our empirical analysis comprises seven reform events in which countries strengthened their creditor participation index (Brazil in 2007, China in 2009, Finland in 2006, France in 2010, Israel in 2014, Italy in 2008, and Spain in 2006). Of these seven treatment countries, we identify four as the high democratic countries, and three as the low democratic (hence, more autocratic) countries.

We begin with the universe of loans in the DealScan database between 2004 and 2016. We drop the loans issued in countries for which we do not have information on democracy from the Polity IV Project database. We further exclude countries with fewer than 10 syndicated loans during our sample period. We also drop the loans issued in the US, as otherwise the size of the US market is such that it would overpower the control sample. Finally, we drop the loans from one country (Colombia) since this country experiences a fall in the creditor participation index during the sample period. Table 3.2 separately reports the summary statistics for the loan-level, borrower-level, and borrowers' country-level characteristics.

The identification strategy relies on the assumption that the passage of the reform event is exogenous and not correlated with country-level characteristics. In order to address this concern, we use a propensity-score based matching technique to control for observable differences between the treated and non-treated countries. We form two sets of control groups – the first control group comprises all non-treatment countries in our sample, and the second control group comprises the non-treatment countries which are (observably) similar to the treatment countries using a propensity-score based matching technique based on macroeconomic characteristics (GDP per capita, annual GDP growth rate, the annual change of regional trade). The list of countries and events is in Appendix A.

3.4.2 Variables

Our dependent variable is (the natural log of) the all-in-drawn spread, *AISD*, which is the spread of the loan facility over the London Interbank Offered Rate (LIBOR) plus any annual fees that borrowers must pay lenders. *AISD* reflects the cost of credit (see, Qian & Strahan 2007, Bae & Goyal 2009, Ivashina 2009), and all else being equal, it is also a reasonable *ex ante* proxy to reflect the riskiness of a borrower and/or the risk-taking of banks. The average loan in our sample has a spread of 173 basis points. We control for several loan-level characteristics in the regressions. *Loan amount* is the natural logarithm of the loan amount. *Number of lenders* is the number of banks participated in the syndicated loan. The average number of lenders in our sample is approximately 14. *Maturity* is (the natural log of) the maturity of the loan in months. The average loan in our sample has a maturity of around 4.8 years. We also employ a set of loan-level variables on the use of covenants, performance-pricing provisions, and information on collateral usage, which indicate lenders' judgement on the risks of the loan. The variable, *Covenants*, is the number of covenants included in the loan contract. *Collateral* is an indicator variable which takes the value of 1 if the loan facility is secured, and zero otherwise; 30.6% of the loans in our sample are secured. The indicator variable, *Performance provisions*, takes the value of 1 if the loan facility contains performance-pricing provisions, and zero otherwise.

We control for several firm-specific characteristics in the regressions since the heterogeneity in borrowers is likely to have impacts on loan spreads. *Firm Size* is the natural logarithm of total firm assets to measure firm size with the sample mean 10.044. Larger firms are generally more diversified, matured and they have a higher reputation and lower default risks, suggesting that larger firms are more likely to get loans with lower costs. *Market-to-book* is the ratio of the market value of assets to the book value of assets, and it reflects firms' growth potential. On the one hand, growth firms generally face higher contracting costs and would lose more of their value when they are in financial distress. Also, stockholders in higher growth firms are more likely to take on projects with higher risks. On the other hand, higher growth firms tend to have more access to valuable projects. Therefore, firms' growth can affect the cost of credit in either way. *Tangibility* and *Leverage* are the ratio of tangible assets to total assets and the ratio of total debt to total assets, respectively. The average tangibility and leverage for the borrowers in our sample are 32.40% and 25.43%, separately. Tangibility can reduce the cost of financial distress since firms with higher tangibility have a higher capacity to pledge assets and face a smaller loss of value when firms are in risks. In addition, tangible assets are more transparent and with lower asymmetric information, which makes firms be monitored well. Therefore, higher tangibility suggests lower credit costs. Moreover, higher leverage indicates both higher credit risks and/or higher loan demands, which typically tends to have higher interest rates.

We obtain country-specific characteristics from several publicly available sources, e.g., World Bank Indicator (WDI), and these variables are observed at the country-year level. Bank loan contracts will also be affected by economic development since the level of economic development is associated with the loan demands to a large extent. The log of GDP per capita (*GDP per capita*) and annual GDP growth rate (*GDP growth*) reflect the level of economic development in a country. The annual change in total trade in goods and services (in USD) between the domestic country and the region, *Regional trade*, controlled for changes in regional trade flows.

3.4.3 Methodology

We identify the impact of creditor participation on the cost of credit using a staggered difference-in-differences (DID) research design. For this purpose, we estimate the following regression:

$$Spread_{lbfct} = \alpha_c + \beta_t + \gamma_{c-sic} + \beta_1 Treated_c * Post_t + \beta_2 L_{lt} + \beta_3 F_{ft} + \beta_4 C_{ct} + \varepsilon_{lbfct} \tag{3.4.1}$$

The dependent variable, *Spread*, is at the loan-level. The loan is issued by the lead bank of the syndicate *b*, to firm *f*, in country *c*, in year *t*. $Treated_c$ equals 1 if a country has experienced an increase in the creditor participation index during the sample period, and zero otherwise. If a reform event takes place in country *c* in year *t*, $Post_t$ equals 1 for that year and beyond (for the remainder of the sample), and zero otherwise. The coefficient of interest is β_1, which reflects how an increase in credit participation affects the cost of credit, *Spread*. It is expected to capture the negative effect of an increase in creditor protection on the cost of credit when the low democracy sub-sample is used (based on Hypothesis 1).

An important issue concerns the identification of the interaction effect of creditor protection and democracy on the cost of credit. In order to isolate whether the interaction of legal protection of creditors and the political regime affects loan spreads, we include a set of time-varying loan-level, firm-level and borrower's country-level characteristics as the control variables to address the potential bias due to omitted variables. In addition, we include country, year, and country-industry fixed effects in each specification to further address any potential unobserved characteristics. The country fixed effects control for the time-invariant variation across countries and subsume the coefficient on $Treated_c$, while the year fixed effects absorb the time-varying shocks and subsume the coefficient on $Post_t$. The country-industry fixed effects based on the 2-digit SIC code are included to control for the unobserved industry-related characteristics for each country. These sets of fixed effects capture the effect of unobserved characteristics which may affect loan pricing. We cluster the standard errors at the country-level since some of the explanatory variables are at the country-year level (Moulton 1990).

A recent set of papers demonstrate that the coefficients from the standard TWFE models do not capture the straightforward weighted average treatment effects as TWFE estimates for one relative-time period are contaminated by the causal effects of other relative-time periods if the staggered treatment timing exists (Callaway & Sant'Anna 2021, Sun & Abraham 2021, Roth et al. 2023, et al.). In order to address this concern, we use two separate approaches which are robust to the presence of heterogeneous treatment effects when the treatment adoption is staggered: the imputation approach of Borusyak et al. (2021) and the two-stage difference-in-differences approach developed by Gardner (2022):

1. In the imputation approach, we derive an efficient robust estimator. In the imputation procedure, we first use the non-treated observations only to fit the unit/group and time fixed effects. Then, using these fixed effects we impute the untreated potential outcomes which allows us to estimate a treatment effect for each treated unit. Finally, we calculate the weighted sum of these treatment effects with weights corresponding to the estimand of interest (Borusyak et al. 2021).

2. In the two-stage difference-in-differences approach, the first stage estimates the group, time fixed effects, and potentially the covariates, only using the subsample of untreated observations,

to predict counterfactual outcomes. The second stage subtracts these estimated effects from the observed outcomes to get the residualized outcomes, and the residualized outcomes are regressed on the treatment variable to estimate the treatment effects.

In the imputation approach, we only report results without any control variables because the convergence of standard errors is not achieved when including control variables. In the two-stage difference-in-differences approach, we include the control variables.

Hypothesis 1 predicts that the impact of creditor participation on the cost of credit differs depending on whether we look at democratic or autocratic countries. We use the Polity IV country-year measure for the level of institutional democracy (as in Acemoglu et al. 2019, Delis et al. 2020). The variable takes values between 0 and 10, with higher values indicating higher levels of institutional democracy. Within the set of treated countries, we label a country as a high (resp. low) democracy country if the mean value of *Democracy* for this country is above (resp. below) the median. We estimate the effects of an increased creditor participation right on the cost of credit for each sub-sample, separately.

3.5 Results

3.5.1 Results in the low democratic countries

In Table 3.3, we examine how an increase in the creditor participation affects the cost of credit in the low democratic countries. The coefficients in the first two columns are estimated by using the imputation approach. In Specification (1), all control countries are included, and in Specification (2), only the matched control countries for the low democracy treated countries are kept. Regarding the results estimated by the imputation approach, the coefficient on an increase in the creditor participation rights is negative and statistically significant at 5% and 1% levels in the first and second columns, respectively. The lower loan spreads are consistent with the idea that creditors are more willing to benefit loan spreads when they have greater powers during bankruptcy and reorganization. In the last four columns, we estimate the relationship between the loan spreads and an increase in creditor participation in the low democratic countries by using the two-stage difference-in-differences method with only the borrowers' country-level control variables and all control variables, separately. The coefficient on an increase in creditor participation is negative and statistically significant in all columns, which are consistent with the results in the imputation approach. To gauge the economic significance of the effect, note that in all regressions *the interaction terms* obtain negative coefficients that range between 22 and 74 basis points, and are statistically significant - depending on the specification; this accounts between 12.7% ((22/173)*100) and 42.8% ((74/173)*100) of the mean spread in the sample. Overall, the evidence in Table 3.3 suggests that an increase in creditor participation leads to lower loan spreads in the low democratic countries where the spreads are high.

3.5.2 Results in the high democratic countries

In Table 3.4, we test the relationship between the increase in creditor participation and loan spreads in the high democratic countries. Again, the first two columns show the results by using the imputation technique without any control variables, and the last four columns present the results by using the two-stage difference-in-differences approach with the borrowers' country-level control variables and all control variables, separately. In columns 1, 3, and 5, all control countries are included, and columns 2, 4, and 6 only use the matched control countries for the high democracy treated countries. In the imputation approach, the coefficient on the increase in creditor participation rights is positive, but only statistically significant when the full control countries are used. However, in the two-stage difference-in-differences approach, the coefficient is statistically insignificant in all columns. Overall, these results indicate that in the high democratic countries, when the cost of credit is already low, an increase in creditor participation does not have a significant impact on loan spreads.

In summary, our results provide evidence that greater creditor participation rights lead to the provision of loans with lower prices in the low democratic countries only. While, in the high democratic countries, the cost of credit is already low, so greater creditor protection does not have significant impacts on reducing loan spreads. Therefore, our finding supports the hypothesis that democracy and creditor participation rights are substitutes.

3.5.3 Parallel trends

In this section, we test whether the parallel trends assumption is satisfied. Using the imputation approach, we perform a test for the parallel trends by a separate regression on only the untreated observations, of the potential outcome on a set of dummies for 1, 2, and 3 years before the treatment year. Then, we plot the dynamic coefficients obtained from the imputation estimator.

In Figure 3.1, we plot the dynamic effects in the low democratic sub-sample. The pre-treatment coefficients are statistically insignificant, confirming that there are no significant pre-trends, and the post-treatment coefficients are negative and statistically significant across the post-treatment years.

In Figure 3.2, we plot the dynamic effects for the high democratic sub-sample. Similarly as above, the pre-treatment coefficients are statistically insignificant, which also confirms that there are no significant pre-trends in the high democratic countries. The post-treatment coefficients are statistically insignificant, consistent with the regression results that the increase in creditor participation does not have a significant impact on the cost of credit in high democratic countries.

3.6 Conclusion

In this chapter, using global syndicated loan-level data for the 2004- 2016 period, we examine how the cost of credit is affected by the interaction of an increase in creditor participation and democracy. Our empirical evidence relies on the increases of creditor participation index across seven countries between 2004 and 2014. We use the all-in-drawn spread (*AISD*) from the LPC DealScan database as the dependent variable to measure the cost of credit. We label a treated country as a high (resp. low) democratic country by using the mean value of *Democracy* for this country, which is obtained from the Polity IV Project database.

We test a key hypothesis, which is the effect of an increase in creditor participation rights on the cost of credit differing depending on whether we look at the democratic or autocratic country. We find evidence that the stronger creditor participation rights lead to a reduction in the loan spreads only in the low democratic countries, while in the high democratic countries, the effect is statistically insignificant in most specifications. We highlight that creditor participation is more valuable in the low democratic countries. The two are substitutes. We interpret these findings by the fact that under greater creditor participation rights, creditors tend to provide loans with a lower price since they can anticipate a higher recovery rate when the borrower is in the event of bankruptcy; and also there is a higher competition among credit supply, which would cause a decline in loan spreads. However, if the borrower's country is at a higher level of democracy and the loan spreads are already low, the stronger creditor protection cannot further decrease the loan spreads.

The key contribution of this chapter relates to the substitution effect. I hypothesise that creditor protection and democracy act as substitutes in the effects on loan spreads. To the best of our knowledge, this interaction effect has not so far been explored in the existing literature. We find strong evidence that the increase in creditor participation reduces loan spreads in the low democratic countries only. Our finding is important for regulators to take into account the interaction impacts of creditor participation rights and democracy on the cost of credit for firms.

Figure 3.1. **Dynamic effects of creditor participation in the low democracy sub-sample.**

This figure plots the dynamic effects of creditor participation on loan spreads in the low democratic countries by using the event-study plots in the imputation approach. Full control group is used. 95% confidence bands are shown, using standard errors are clustered by borrower's country.

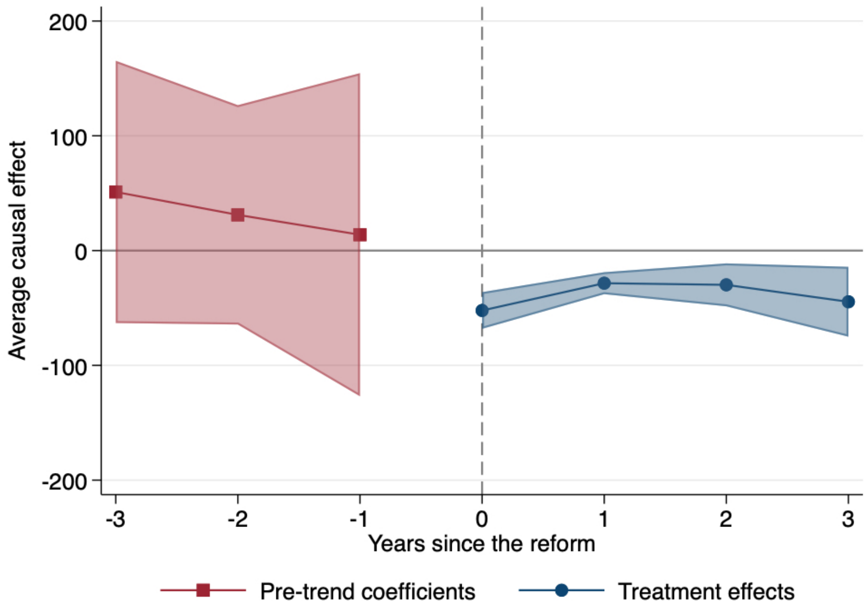


Figure 3.2. **Dynamic effects of creditor participation in the high democracy sub-sample.**

This figure plots the dynamic effects of creditor participation on loan spreads in the high democratic countries by using the event-study plots in the imputation approach. Full control group is used. 95% confidence bands are shown, using standard errors are clustered by borrower's country.

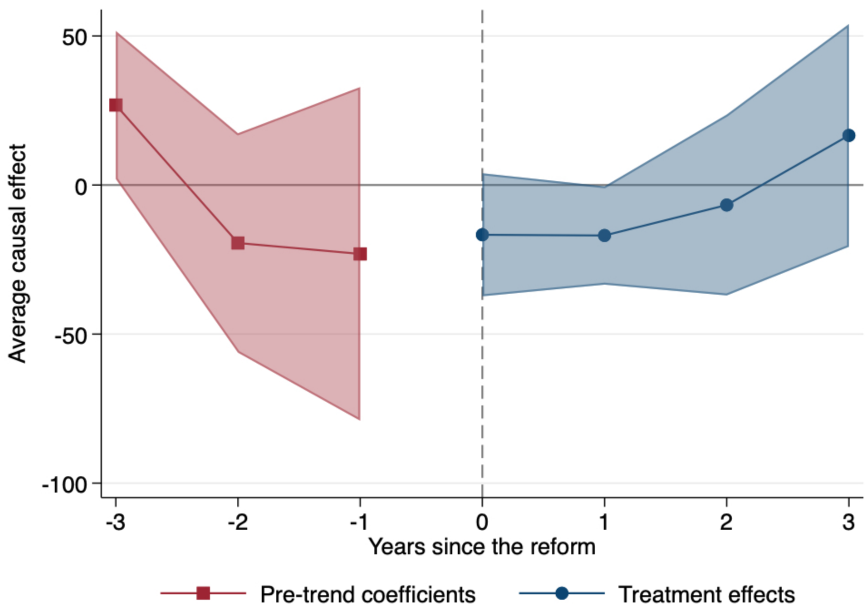


Table 3.1. **Variable definitions and sources**

Variable	Definition	Source
Panel A: Dependent variable		
AISD	All in spread drawn, defined as the sum of the spread over LIBOR plus the facility fee.	DealScan
Panel B: Loan characteristics		
Loan amount	Log of the loan facility amount in millions USD.	Idem
Maturity	Log of loan duration in months.	Idem
Collateral	Dummy equal to one if the loan is secured with collateral, zero otherwise.	Idem
Number of lenders	The number of banks involved in the syndicated loan.	Idem
Performance provisions	Dummy equal to one if the loan has performance-pricing provisions, zero otherwise.	Idem
Covenants	The number of covenants in the loan contract.	Idem
Panel C: Borrower characteristics		
Firm size	Log of total firm assets.	Compustat
Market-to-book ratio	The ratio of the market value of assets to the book value of assets.	Idem
Tangibility	The ratio of tangible assets to total assets (multiplied by 100).	Idem
Leverage	The ratio of total debt to total assets (multiplied by 100).	Idem
Panel D: Borrower's country characteristics		
GDP per capita	GDP per capita in constant prices.	WDI
GDP growth	Annual GDP growth rate.	Idem
Regional trade	Annual change in total trade in goods and services (in USD).	UN Comtrade

Table 3.2. **Descriptive statistics.**

The table reports the number of observations, mean, median, standard deviation, minimum, and maximum for the variables used in the empirical analysis. The sample covers the period during 2004-2016.

	Obs.	Mean	Median	S.D.	Min.	Max.
AISD	62,240	172.803	125.000	154.739	-3.00	5775.000
Loan amount(ln)	62,240	19.004	19.599	2.626	3.719	24.470
Maturity	61,946	57.063	60	34.930	1	725
Collateral	62,240	0.306	0	0.461	0	1
Number of lenders	62,240	13.501	12	9.465	1	117
Performance provisions	62,240	0.103	0	0.304	0	1
General covenants	62,240	0.410	0	0.918	0	5
Firm size(ln)	62,059	10.044	9.915	2.410	1.022	18.924
Firm market-to-book ratio	56,580	0.094	0.125	23.296	-1107.247	532.422
Firm tangibility	62,022	32.396	29.141	23.072	0	99.121
Firm leverage	62,059	25.432	22.384	18.150	0	282.378
GDP per capita	51,620	36258.840	38573.200	19031.45	539.626	112417.900
GDP growth	51,620	2.639	2.403	2.948	-10.149	25.176
Trade(ln)	37,309	10.963	11.225	1.253	4.774	13.549

Table 3.3. **Loan spreads and Creditor Participation in the low democracy sub-sample.**

The dependent variable is loan spreads (*AISD*). In columns 1 and 2, we use the imputation approach of Borusyak et al. (2021) without any control variables. In the last four columns, we use the two-stage difference-in-differences approach from Gardner (2022). In columns 3 and 4, only the borrower's country-level controls are included, and columns 5 and 6 additionally include the loan-level and the borrower-level controls. Country, Year, and Country-Industry fixed effects are included in all regressions. Standard errors clustered at the country level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) AISD	(2) AISD	(3) AISD	(4) AISD	(5) AISD	(6) AISD
Increase in Creditor	-22.028**	-26.968***	-30.989***	-73.944***	-26.802**	-70.563***
Participation	(-2.47)	(-2.16)	(-2.63)	(-3.61)	(-1.99)	(-4.84)
Method	Imputation	Imputation	2-stage DID	2-stage DID	2-stage DID	2-stage DID
Control group	Full	Matched	Full	Matched	Full	Matched
Controls	No	No	Country	Country	All	All
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Country	Country	Country	Country	Country	Country
Observations	51,010	10,556	29,170	7,684	25,613	6,617

Table 3.4. **Loan spreads and Creditor Participation in the high democracy sub-sample.**

The dependent variable is loan spreads (*AISD*). In columns 1 and 2, we use the imputation approach of Borusyak et al. (2021) without any control variables. In the last four columns, we use the two-stage difference-in-differences approach from Gardner (2022). In columns 3 and 4, only the borrower's country-level controls are included, and columns 5 and 6 additionally include the loan-level and the borrower-level controls. Country, Year, and Country-Industry fixed effects are included in all regressions. Standard errors clustered at the country level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) AISD	(2) AISD	(3) AISD	(4) AISD	(5) AISD	(6) AISD
Increase in Creditor	32.600***	16.220	17.585	16.944	20.053	32.510
Participation	(2.81)	(1.33)	(1.05)	(1.59)	(0.95)	(1.28)
Method	Imputation	Imputation	2-stage DID	2-stage DID	2-stage DID	2-stage DID
Control group	Full	Matched	Full	Matched	Full	Matched
Controls	No	No	Country	Country	All	All
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Country	Country	Country	Country	Country	Country
Observations	60,146	25,813	36,393	18,817	32,192	16,607

Appendix A. Sample construction: list of countries and regions

Treatment group. Reforming countries, dates of passage of reforms: Brazil (2007, Low), China (2009, Low), Finland (2006, High), France (2010, High), Israel (2014, Low), Italy (2008, High), Spain (2006, High)

Matched control group. These countries were similar to the treatment countries in observable macroeconomic conditions (GDP per capita, GDP growth and the annual change of regional trade), but which did not have reforms.

Countries matched with low democracy treated countries:

Australia, Korea, Mexico, Netherlands, Poland, Sweden

Countries matched with high democracy treated countries:

Austria, Belgium, Denmark, Germany, Japan, Netherlands, United Kingdom

Other countries and regions. In addition to the matched countries, the overall control group includes the following countries and regions:

Argentina, Canada, Greece, India, Ireland, Kazakhstan, Liberia, Luxembourg, Malaysia, New Zealand, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Russian Federation, Saudi Arabia, Singapore, South Africa, Switzerland, Taiwan China, Thailand, Turkey

Chapter 4

The substitution effect of interest rate derivatives usage on bank liquidity, considering the holding purposes of derivatives

4.1 Introduction

Managing risks effectively is crucial for a bank because of the role of financial intermediaries played by banks. If a bank has excessive risk exposures to the market, not only the bank and its customers would suffer, but also the capital markets would lose additional access to get financing (Bliss et al. 2018). In general, banks can manage their risks either on the balance sheet (e.g., holding liquidity) or off the balance sheet (e.g., financial derivatives usage). Specifically, banks can invest in safer (i.e., more liquid) assets. Keeping higher liquidity could alleviate insolvency risks because liquid assets can be converted into cash more easily (Sinkey Jr & Carter 2000). Managing liquidity prudently is beneficial to financial stability. However, liquidity is costly because of the lower interest rate of investing in liquid assets. Holding too much liquidity can reduce investment opportunities and negatively affect profitability. Thus, the objective in holding higher liquidity is to trade-off the higher stability against the potential higher opportunity costs. Hence, it could be argued that finding an alternative and less costly risk management method that may act as a substitute for liquidity holding is meaningful. The financial derivative instrument is considered as an efficient method to manage bank risks since derivatives provide an easy and effective way to hedge the residual risk from banks' operations. The prominent motivation behind using financial derivatives is to hedge risk exposures, which ultimately increases bank stability and value. Elliott et al. (2003) argue that derivatives are able to not only hedge risk exposures but also take a safe position in predicting trends of the market. Thus, using financial derivative instruments can be an alternative approach to managing bank risks. However, the substitution effect of financial derivatives on liquidity is hitherto underexplored.

In this chapter, I explore how bank liquidity holding is affected by financial derivatives usage. The importance of holding liquidity and using financial derivatives in bank risk management has been well documented separately (see, Shanker 1996, Venkatachalam 1996, Drehmann & Nikolaou 2013, Ratnovski 2013, etc.). However, the substitution effect between liquidity and derivatives in terms of risk management has not been previously considered. I provide empirical evidence on whether and how financial derivatives are used as a substitute for liquidity to manage risks in banking.

I develop two hypotheses that predict the relationship between financial derivative instruments and bank liquidity. The derivative-hedging hypothesis points out that financial innovation instruments used for hedging purposes would lead to a lower liquidity holding. Hedging with derivatives is able to decrease risk exposures through reducing the volatility of cash flows and potential costs of financial distress, and further mitigate the under-investment problems because of liquidity constraints. Under this hypothesis, there might be an alternative between holding higher liquidity and using derivatives with the hedging purposes, where the latter can substitute for the former in terms of the risk management. Contrarily, the derivative-trading hypothesis predicts that using financial derivatives for trading cannot decline bank liquidity. This hypothesis argues that bank risk-taking may increase when the derivative positions are traded to seek profits. Banks that are exposed to additional risks from holding speculative derivative positions should keep a certain level of liquid assets to manage risks and have no incentives to reduce their liquidity holding. Thus, because of the different holding purposes of financial derivatives, i.e., trading and hedging, I hypothesise that the effect of the financial derivatives usage on bank liquidity would depend on the incentives that banks hold those derivatives for.

This chapter empirically examines how bank liquidity is affected by the interest rate derivatives usage with different holding purposes. I focus on the interest rate derivative since it is the most important innovation tool for banks and the holding positions on it are reported more completely. Specifically, I test if a bank that reports holding more interest rate derivative positions for hedging purposes effectively diminishes its liquidity holding. Thus, I should collect data on the interest rate derivative positions with different holding purposes.

Because of the riskiness of financial derivatives usage, and the complexity and dynamic nature of derivatives, the derivatives disclosure requirements have been more stringent under various accounting regulations. For instance, SFAS Nos. 105, 107, 109 and 133 have been issued to regulate the derivatives activities (Yang et al. 2006). In practice, banks are required to report their derivative positions for 'held for trading purposes' and 'held for purposes other than trading', separately. The derivatives held for the trading purposes are taken for seeking higher profits, while those held for non-trading purposes are motivated by hedging risks (Dewally & Shao 2013). The data availability of interest rate derivatives holding for different purposes gives me the opportunity to examine if the effect of derivatives usage on liquidity holding in banking differs depending on its holding purposes.

I collect annual bank-level data for US Bank Holding Companies (BHCs) covering the sample period from 2012 to 2019. I exclude banks that do not report information on their interest rate derivative positions to construct the sample. This gives me a sample of 792 banks with 3,806 observations. I study the impact of using derivatives on bank liquidity by regressing the interest rate derivative usage with different purposes on bank liquidity measures (i.e., *Liquidity Ratio*, and *Liquid Assets/TA*). I find that banks that use more interest rate derivatives for purposes other than trading have a reduction on their liquidity, economically showing that one standard deviation increase in a bank's interest rate derivative usage for the hedging purposes decreases its liquidity ratio by about 3%. The finding suggests that the interest rate derivatives with hedging purposes can effectively substitute for bank liquidity. In contrast, banks that use interest rate derivatives for the trading purposes do not have a statistically significant impact on their liquidity holding in most specifications. My results indicate that the relationship between the bank interest rate derivatives usage and bank liquidity depends on interest rate derivatives usage purposes. In addition, I conduct several additional tests to confirm the findings.

After the global financial crisis in 2007-2009, Basel III propose two liquidity ratios, the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR), to respond to bank liquidity risks. The LCR is calculated by dividing a bank's stock of unencumbered high-quality liquid assets (HQLA) by its projected net cash outflows for a 30-day liquidity stress scenario. Regulators require that this ratio should be at least 1. The Federal Reserve's proposed internal stress testing requires each bank to conduct internal stress tests based on its own characteristics, such as riskiness and size, et al. Under the internal stress tests, riskier banks face a higher cash outflow since depositors may request to withdraw their deposits due to the higher insolvency risks of them. Hence, riskier banks need to hold more liquidity positions to cover the potential withdrawing needs and satisfy the LCR, which means that the LCR requirement is more binding for them. While, for safer banks, they have more flexibility in liquidity holding since liquidity requirements are de facto lower for them compared to riskier banks. Furthermore, because of the close association between bank liquidity and solvency, higher solvency reduces the possibility of a loss of confidence by funders, meaning that the solvent (safer) banks can get external funding more easily. In contrast, funders would be unwilling to lend to riskier banks. Therefore, riskier banks are more likely to hold a relatively higher level of liquid assets[1]. I conjecture that the substitution effect of interest rate derivatives holding for the hedging purposes on bank liquidity would be stronger for safer banks. In order to test the heterogeneous effects across safer and riskier banks, I interact the use of interest rate derivatives for the hedging purposes with an indicator variable of safer banks. Consistent with Hypothesis 3, I find evidence that safer banks reduce their liquidity more when they hold the hedging purpose interest rate derivatives, suggesting that the substitution effect is stronger for safer banks.

I contribute to the literature on several dimensions. First, I contribute to the literature on bank risk and liquidity management. The previous literature presents a set of determinants of liquidity, such as credit risk exposures, profitability, and bank size, et al., but there is no paper to reveal the effect of the interest rate derivatives usage on bank liquidity holding. Second, most existing literature exploits the influences of banks' derivative usage on bank risk-taking and performance but ignore the effects of derivative usage on bank liquidity. I examine whether and how the usage of interest rate derivatives affects liquidity holding in banking. In addition, I pay attention to the effects of financial derivatives by explicitly considering the different purposes for which derivative instruments are held, which is ignored by previous literature. To sum up, I contribute to the literature by showing that the usage of financial derivatives with hedging purposes and liquidity holding are substitutes for bank risk management. Third, data availability introduces a primary challenge for the analysis regarding the impacts of the derivatives usage. Several previous papers that investigate the financial derivative positions are forced to construct dummy variables on whether an institution uses any derivatives or not (Bliss et al. 2018, Chang et al. 2018, Fiedor & Killeen 2021). On the contrary, I measure the derivative usage through the intensity of derivatives using (scaled by total assets). Additionally, I provide a new measurement of the net interest rate derivatives for banks, promoting a better analysis.

4.2 Literature review

This study relates to two strands of existing literature, one being on the bank risk management, and the other one on the financial derivative instruments.

[1] I compare the average liquidity holding across the riskier and safer banks and find that the average liquidity in riskier banks is statistically significantly higher than that of safer banks.

4.2.1 Bank risk management

This chapter relates to the literature on bank risk management. In the past decades, due to the role of intermediaries played by banks, the importance of risk management in the banking industry has been increasingly realized, especially after the 2007-2009 financial crisis. Maintaining financial stability is necessary for any country, so financial institutions need to manage their risks properly.

In a frictionless Modigliani & Miller (1958) world, institutions do not need to waste resources to manage their risks as shareholders can do so more effectively by using a well-diversified portfolio. However, intermediaries would not exist in this frictionless world. In reality, in the presence of frictions, such as the existence of the moral hazard and adverse selection problems, intermediaries (banks) invest in private information that makes bank loans more illiquid (Diamond 1984) and more difficult to trade, especially during the crisis period. The cost of a bank's insolvency is high when their loans incorporate private information, so banks are incentivised to avoid failure by managing their risks, including holding enough capital and liquid assets, etc.

Drehmann & Nikolaou (2013) state that liquidity risk is the most important risk faced by banks. Inefficient management on liquidity may lead to not only a sale of a bank itself but also a collapse of the whole financial system when bank panic occurs. However, prior to the 2007-2009 financial crisis, banking regulation focused mostly on bank capital requirements, but the literature and regulation on bank liquidity management did not get much attention. Basel I and II accords focused on bank capital regulation and excluded liquidity regulation. Until Basel III, banking supervision introduces two liquidity ratios: the Liquidity Coverage Ratio (LCR) to reflect the short-term liquidity risk and the Net Stable Funding Ratio (NSFR) as a measurement of the long-term liquidity risk, - to manage bank liquidity risks. These new requirements inevitably have significant influences on banks because they have to hold a higher level of liquidity position, which further affects the liquidity creation function of banks (Horváth et al. 2014). Except for the regulation side, most of the literature also focuses on credit risk, and not many works analyse liquidity management; however, in this chapter, I contribute to the bank liquidity management literature.

Previous liquidity literature mostly concentrates on determinants of liquidity and the effects of liquidity on bank performance. Vodova (2011) seeks to identify determinants of liquidity of Czech commercial banks within the period from 2001 to 2009. She uses different liquidity measures and finds empirical evidence indicating that different factors, such as bank capital adequacy, share of non-performing loans, size, interbank interest rates, and inflation rate, et al, affect bank liquidity in different ways. However, Vodova (2011) and the existing literature both ignore whether bank liquidity holding is affected by any instruments on the off-balance sheet side, such as the financial derivative instruments, which is highlighted in this chapter.

Another strand of the banking liquidity literature emphasises the link between bank liquidity management and financial institution's performance. Many factors significantly impact a bank's performance, including macroeconomic and bank-specific factors both, such as GDP, inflation, capital adequacy, asset quality, and credit risk management, et al. Besides these factors, liquidity management has also been argued to have significant influences on banks' performance. However, the correlation between liquidity and banks' performance is mixed. Several papers infer that proper liquidity management practices improve banks' performance (Bourke 1989, Lartey et al. 2013, Hakimi & Zaghdoudi 2017, et al.). They generally argue that banks with more liquidity holding are more likely to have higher stability and good reputation in funding markets, which could further reduce their financing costs and hence increase profitability. In contrast, a set of papers demonstrate a negative relationship between bank liquidity and performance (see, Molyneux & Thornton 1992, Pasiouras & Kosmidou 2007, Mamatzakis & Bermpei 2014, et al.). Their findings support the conventional wisdom that liquidity holding entails higher opportunity costs to banks. From this point of view, it is worth investigating whether there is any alternative approach to managing bank risks instead of holding a higher level of liquidity.

Apart from the above-mentioned literature, there is a small set of papers exploring the effects of bank liquidity on the asset-side of the balance sheet. Cornett et al. (2011) use a quarterly panel data from 2006 to the second quarter of 2009 to investigate how banks reacted to the liquidity risks during the 2007-2009 financial crisis by adjusting their liquidity holding, and how these adjustments had impacts on the credit availability. They find that banks facing higher liquidity risks increased their liquidity holding, and led to a decline in their loan supply. In addition, they conclude that banks with more stable funding sources, such as core deposits and capital, tend to continue providing credit compared to other banks. Similarly, Hanson et al. (2015) point out that financial institutions with less stable sources of financing, i.e., uninsured wholesale finance, choose to hold relatively lower liquidity risk assets.

In contrast to the above, this chapter considers how the liquidity holding is affected by the use of a financial innovation approach, i.e., financial derivatives, on the off-balance sheet to manage risks in banking. This substitution effect of financial derivatives on liquidity has so far been unexplored in the extant literature, which helps this chapter contribute to the banking liquidity literature.

4.2.2 Financial derivative instruments

This section illustrates two strands of existing financial derivatives literature: (i) the rationale for derivatives usage and (ii) the impacts of derivatives usage.

4.2.2.1 Incentives of derivatives usage

In general, BHCs can hold derivative instruments for two roles: end-user or dealer or both. As end-users, a bank is able to hedge its risk exposures by holding derivatives. In a frictionless Modigliani & Miller (1958) world, the overall value of banks is not affected by how the bank is financed nor by its hedging activities. However, in an imperfect market with frictions, banks would be motivated to hedge, as hedging increases its value by having a higher after-tax cash flow (and lower expected tax liability) (Smith & Stulz 1985, Froot et al. 1993, Nance et al. 1993, Sinkey Jr & Carter 2000), a reduction in the probability and cost of financial distress (Froot et al. 1993, Aretz et al. 2007), a lower cost of external financing and underinvestment (Froot et al. 1993), and a decrease in the cost of agency as well as asymmetric information (DeMarzo & Duffie 1995). Indeed, Duffee & Zhou (2001) suggest that credit derivatives hedge banks against its' financial distress and relieve the lemon problem arising from the bank information advantage about the credit quality of loans. Campello et al. (2011) state that hedging users typically pay a lower interest spread, which gives them more space to invest. In contrast, if banks hold derivatives for the trading purposes (i.e., as a dealer), they can generate more non-interest income and strengthen their relationships with clients by participating in derivative markets (Brewer et al. 1996). Derivatives used for trading purposes are profit-seeking instruments for banks (Dewally & Shao 2013). Chance & Brooks (2015) state that proper derivatives usage can not only relieve potential risk exposures but also boost profits against market turmoil.

4.2.2.2 Effects of derivatives usage

This chapter contributes to a number of related literature streams that investigate the impacts of derivatives usage (e.g., Hentschel & Kothari 2001, Bartram et al. 2011, Brewer III et al. 2014, Deng et al. 2017). Most extant literature examines the effects of financial derivatives usage on risk-taking, but draws different conclusions. Numerous works have documented that the relationship between the usage of derivative activities and bank risk-taking is negative (Shanker 1996, Venkatachalam 1996, Guay 1999, Buston 2016, Bliss et al. 2018, Caglio et al. 2019). They generally argue that financial derivatives can effectively manage banks risks with the hedging purposes by smoothing earnings and reducing volatility. In contrast to these studies, from a sceptical view, there is a set of papers claiming that there is a positive correlation between derivatives usage and risk-taking (see, Hirtle 1997, Minton et al. 2009, Sundaram & Willey 2009, Li & Marinč 2014, Mayordomo et al. 2014, Trapp & Weiß 2016), because of the speculation characteristics of financial derivatives. Buffet (2002) refers to financial derivative instruments as 'a weapon of mass destruction'. Moreover, another perspective has shown that derivative activities do not have significant influences on risk exposures (e.g., Hentschel & Kothari 2001, Gilkeson & Smith 2006, Mayordomo et al. 2014).

The conflicting findings may be attributed to the difference in the sample and time period. However, another possible explanation for such contradictory results is the different purposes of banks' usage of derivatives, i.e., hedging or speculation. Indeed, numerous papers study the impacts of aggregate derivatives activities (e.g., Nguyen & Faff 2010, Bartram et al. 2011, Mayordomo et al. 2014, Ahmed 2021), and also there is extensive literature suggesting that the impact of derivative usage varies across different derivative categories based on the different underlying assets (e.g., Cyree et al. 2012, Brewer III et al. 2014, Li & Marinč 2014, Mayordomo et al. 2014). However, there is little evidence on the impacts of derivative positions by distinguishing banks' derivatives usage according to their holding purposes. Contrasting with these papers, I distinguish the purposes of the derivatives usage and primarily focus on the impacts of interest rate derivative activities used for hedging to examine the substitution effect of interest rate derivatives usage on bank liquidity.

In addition, the previous literature pays more attention to the effects of derivatives usage on systemic risks (Capelle-Blancard 2010, Li & Marinč 2014) and bank performance (Bliss et al. 2018), but no paper has examined the effects of financial derivatives usage on liquidity. Hence, it is of most importance to understand whether and how bank derivatives usage affects liquidity holding in banking, and investigating this question can provide new insights for bank risk management.

4.3 Hypothesis development

4.3.1 Bank liquidity holding and financial derivatives

How does the financial derivative instrument substitute for liquidity holding to manage bank risk-taking? The effect could depend on the purposes for which financial derivatives are used.

Derivatives are argued as an effective approach to managing bank risk-taking since they are more flexible, efficient, and resilient to disperse banks' risks (Greenspan 2004). Derivatives usage decreases the volatility in bank value, which further decreases the likelihood and potential costs of financial distress (Smith & Stulz 1985). Financial derivatives have become a prominent tool in financial risk management. A bunch of papers state that the usage of financial derivatives is beneficial insofar for the financial stability (e.g., Barton 2001, Bliss et al. 2018, Caglio et al. 2019, etc.), supporting the hedging function of derivatives. At the same time, because of the speculation characteristics of derivatives, the use of derivatives may introduce higher risks for banks. In particular, after the 2007-2009 global financial crisis, a lot of scepticism was raised on derivatives due to the complex nature of them.

How the financial derivatives usage affects bank liquidity positions is unclear. I develop two hypotheses to predict the relationship between using financial derivatives and liquidity holding in banking since banks may participate in financial derivatives transactions for hedging or trading purposes.

Banks can use financial derivatives for hedging purposes to manage risks since hedging can smooth the volatility of future cash flows from unfavourable fluctuations in risk exposures and hence reduce risks. Simply put, hedging can be described as a way to manage risks by using derivatives trading with two parties who hold opposite risk exposures. Although keeping a higher level of liquidity is able to limit bank risk-taking, banks may have to reduce investments due to the liquidity constraints if they hold too many liquid assets. With derivatives hedging, banks are able to invest in projects directly by reducing the fluctuations of cash flows. Smoothing the volatility of future cash flows is the priority for banks to use derivatives for hedging since it will decrease bank riskiness and increase bank value by minimizing the expected tax liability and the cost of financial distress, which would ensure that banks can keep enough internal funds to invest in projects. Several papers state that financial derivative usage is able to alleviate the under-investment problems (Bessembinder 1991, Chaudhry et al. 2014). Therefore, in order to have adequate funds and mitigate the under-investment concerns, banks have incentives to use financial derivatives for hedging purposes to manage their risks rather than keeping a higher level of liquidity. In other words, when banks engage in the financial derivatives market to hedge risks, the use of interest rate derivatives for hedging purposes substitutes for bank liquidity to some extent in terms of risk management. I expect that liquidity holding is negatively associated with the use of interest rate derivatives for the hedging purposes. I propose the derivative-hedging hypothesis as follows:

Hypothesis 1: Banks that hold a higher level of interest rate derivatives for the hedging purposes are more likely to reduce their liquidity. I call interest rate derivatives for the hedging purposes as a substitute for banking liquidity in terms of bank risk management.

Although the financial derivative is mainly used for risk management, it is also a potential source of vulnerability. Specifically, banks can engage in the financial derivatives market with the trading purposes which seeks to pursue more profits. This may increase bank profitability, but it also amplifies the volatility of cash flow, which further deteriorates financial stability. In this case, the bank that uses derivatives for trading purposes may have higher risk-taking. They are not able to decrease their liquidity because they need to keep a relatively higher level of liquidity to respond to any potential risks. Therefore, I expect that banks with higher usage of interest rate derivatives for trading purposes would be less likely to reduce their liquidity. I derive the derivative-trading hypothesis as follows:

Hypothesis 2: Banks who hold more interest rate derivatives for the trading purposes do not have incentives to reduce their liquidity.

Overall, if derivatives are used properly, it will help banks improve their management in risk exposures and further foster economic development by smoothing volatility and increasing investment in the real economy. In this context, financial derivatives used for the hedging purposes would be more likely to substitute for expensive liquidity. However, derivatives may increase banks' riskiness and even cause a collapse or bankruptcy of a bank if they are used for trading profits instead of hedging against risks, which would require banks to keep necessary liquidity to resist risks. Therefore, whether banks use derivatives as a substitute for liquidity depends on the purposes of those derivatives.

4.3.2 Cross-sectional heterogeneous effect

In terms of the heterogeneous effect, I consider whether the substitution effect of interest rate derivatives usage for hedging purposes on bank liquidity holding differs across safer and riskier banks.

In order to manage bank liquidity prudently, Basel III proposed the Liquidity Coverage ratio (LCR), which is calculated by dividing a bank's stock of unencumbered high-quality liquid assets (HQLA) by its projected net cash outflows over a 30-day horizon under a stress scenario specified by supervisors. Regulators require that this ratio should be at least 1. Although the LCR makes one-size-fits-all liquidity run-off assumptions which all banks have to use to determine their liquidity buffer, the Federal Reserve's proposed internal stress testing requires each bank to conduct internal liquidity stress tests based on their capital structure, risk level, size, operations, etc. (Bouwman 2013). Under the internal stress tests, riskier banks face higher insolvency risks, so depositors may be concerned about bank solvency and require to withdraw their money, resulting in higher cash outflows for riskier banks. Therefore, the denominator of the LCR is higher for riskier banks. As a result, those riskier banks need to hold more high-quality liquid assets to satisfy the LCR requirement. The LCR requirement is more binding for riskier banks. Diamond & Kashyap (2016) claim that the generic property of optimal regulations is when banks are less stable, they are required to hold some additional liquidity. In addition, there is a close association between bank liquidity and solvency. In most countries, banks have solvency, and thus have the ability to refinance. If a bank is close to insolvency, investors may be unwilling to lend to it, which creates liquidity risks and leads to the possibility of a bank's failure. Conversely, a bank that is more solvent will be able to attract external funding. Thus, a bank with a higher insolvent risk has more incentives to hold more liquid assets, while for safer banks, they are less likely to keep higher liquidity because they can raise external funds relatively easily and holding higher liquid assets is expensive. Therefore, I expect that safer banks would reduce their liquidity holding more when they use interest rate derivatives for the hedging purpose. I state the hypothesis formally as follows:

Hypothesis 3: The substitution effect of interest rate derivatives for the hedging purposes on bank liquidity holding is stronger for safer banks.

4.4 Data and Methodology

4.4.1 Data

I collect annual bank accounting data from the FR Y-9C reports of US bank holding companies in the SNL financial database. The FR Y-9C reports classify the notional amount of derivative positions based on its underlying types (i.e., Interest rate, Credit, Foreign exchange, Equity, and Commodity and others, derivatives) and holding purposes (i.e., Trading purposes and Purposes other than trading). To alleviate the concerns that the finding might be driven or partly driven by any global shocks, like the financial crisis or the COVID-19, my sample covers the sample period from 2012 to 2019.

To construct the sample, I begin with 3,749 US bank holding companies. Then, I exclude banks with missing observations in the interest rate derivatives positions. I end up with 792 BHCs with 3,806 observations. Including control variables in the regressions reduces the number of observations, so I report baseline regressions both with and without including the control variables in order to retain the largest sample size. I define the main variables used in the regressions in the following section, and Table 4.1 reports the summary statistics. I winsorize continuous variables at the 1^{st} and 99^{th} percentiles to reduce the effects of outliers.

Under the FR Y-9C reports, the derivative positions are reported according to the holding purposes. In general, derivatives held for trading purposes are incentivized by pursuing profits, while those held for purposes other than trading are mainly motivated by hedging. I pay more attention to those 'non-trading' positions to test if the holding of those types of derivatives substitutes for the liquidity positions as a method to hedge risks. I also look at the impact of the derivative positions for the trading purposes. I hypothesise that only the derivatives that are held for the hedging purposes effectively work as a substitute for liquidity. Additionally, I focus on interest rate derivatives in this chapter, because the interest rate derivatives have become one of the most important instruments for BHCs to manage their risks, and the positions on interest rate derivatives are reported more completely (Dewally & Shao 2013).

4.4.2 Variables

4.4.2.1 Interest rate derivatives usage

The Call reports data separate the derivative positions according to its holding purposes, which allows me to measure the gross interest rate derivative for the hedging purposes by the ratio of gross notional of interest rate derivatives for purposes other than trading to total assets, *Gross IR Hedging*. A higher value of *Gross IR Hedging* means a higher intensity of interest rate derivatives used for the hedging purposes for a bank. However, *Gross IR Hedging* is not a perfect measurement because the Call reports data do not disclose the direction of trading. Therefore, I use a new method as an alternative proxy to measure the net interest rate derivatives for hedging, *Net IR Hedging*, related to that of Begenau et al. (2015). *Net IR Hedging* is calculated as follows:

$$Net\ IR\ Hedging_{i,t} = \frac{\Delta MV_{i,t+1}/Asset_{i,t}}{\Delta r_{t+1}} \tag{4.4.1}$$

where, MV_t is the market value of net interest rate derivatives positions for hedging at date t, and $\Delta MV_{i,t+1} = MV_{i,t+1} - MV_{i,t}$ is the market value changes between date t and $t+1$, whereas $\Delta r_{t+1} = r_{t+1} - r_t$ is the relevant benchmark interest rate changes between date t and $t+1$. Intuitively, the sign and magnitude of *Net IR Hedging* position at date t can be inferred from the joint dynamics of interest rates and the market value of the interest rate derivatives between date t and $t+1$. Specifically, if the bank has a positive gain in the market value of the interest rate derivatives hedging positions when the interest rate goes up, then the bank holds a long position in the interest rate derivatives, and vice versa. This measurement is an approximation, but it is a relatively direct measure by using the existing bank accounting data.

Similarly, I measure the gross interest rate derivatives for the trading purposes by the ratio of gross notional of interest derivatives for the trading purposes to total assets, *Gross IR Trading*. Also, I construct *Net IR Trading* to reflect the net interest rate derivative holdings for the trading purposes, following the above methods. In addition, I measure the aggregate interest rate derivative positions by using the total gross notional of interest derivatives scaled by total assets, *Gross IR Using*.

4.4.2.2 Liquidity variables

My basic dependent variable reflects bank liquidity, *Liquidity Ratio*, which is the ratio of total liquid assets to total liabilities. This ratio reflects the ability of a bank to cover its liabilities using its liquid assets positions. Thus, a higher value of *Liquidity Ratio* indicates a higher bank liquidity and a lower risk exposure. I also use the liquid assets scaled by total assets, *Liquid Assets/TA*, as an alternative measure of bank liquidity (Bourke 1989, Demirguc et al. 2003). A higher value of *Liquid Assets/TA* means a higher liquid position for a bank.

4.4.2.3 Control variables

I control for a set of bank characteristics in the regressions. Bank size is measured by using the natural logarithm of the total assets, *Size*. *GrowthTA* is the growth rate in *Size*. Bank profitability is reflected by the return on assets, *ROA*. The average bank in the sample has a *ROA* of 0.963%. *Loan* and *Cash*, which are proxied by the ratio of gross loans to the total assets and the ratio of total cash to the total assets, reflect the bank's business model and cash holding positions, separately. The average bank's loan portfolio of its total assets in the sample is 64.047%, and the average cash holding is 1.789% of the bank's total assets. *Deposit* is proxied using the total deposits divided by the total assets, *Equity* is measured by the ratio of total equity to the total assets, and they reflect the bank's funding structure. Equity holdings make up 10.402% of its total assets. Finally, I control for the bank's operating costs, reflected by the ratio of overheads to the total assets, *Overheads*.

4.4.3 Methodology

In order to identify the impact of interest rate derivatives for different holding purposes on bank liquidity, my major econometric relation takes the following form:

$$Y_{i,t} = \beta_1 * IR\ Derivatives_{i,t-1} + \alpha X_{i,t-1} + \gamma_i + \gamma_t + \epsilon_{i,t} \qquad (4.4.2)$$

where, $Y_{i,t}$ is the dependent variable, measuring the liquidity for bank i in year t. The coefficient on *IR Derivatives* (e.g., *Gross IR Hedging* or *Gross IR Trading*), β_1, is the main variable of interest, which captures the effects of the interest rate derivatives for different holding purposes on the outcome variable. I include the bank fixed effects, γ_i, and year fixed effects, γ_t, to control for the time-invariant bank characteristics and time-varying shocks, respectively. $X_{i,t-1}$ is a vector of control variables that may affect bank liquidity, and lagged by one period to mitigate the endogeneity concerns. The Equation (4.4.2) is estimated by using OLS, and I cluster the standard errors at the bank level.

4.5 Results

4.5.1 Baseline results

Table 4.2 reports the baseline regression results. The independent variable of interest is *Gross IR Hedging*. In columns 1 and 2, the independent variable is *Liquidity Ratio*, and the regression results are without and with control variables included, separately. The variable of interest, β_1, which is the coefficient on *Gross IR Hedging*, is negative and statistically significant in all specifications. In terms of the economic magnitude of the impacts, the usage of interest rate derivatives for the hedging purposes leads to a reduction in *Liquidity Ratio* by 0.026% (in the specification which includes the controls), indicating that one standard deviation increase in a bank's interest rate derivatives positions for hedging decreases its liquidity by about 3%. The results suggest that banks with more interest rate derivatives positions for the hedging purposes are more likely to reduce their liquidity holding, consistent with Hypothesis 1. Columns 3 and 4 present the results for *Liquid Asset/TA*, used as an alternative variable of *Liquidity Ratio*, and also the regressions are without and with control variables included, respectively. The coefficients on β_1 is negative and statistically significant in both columns, which is consistent with the coefficient when using *Liquidity Ratio* as the dependent variable. In summary, banks that use more interest rate derivatives for the hedging purposes tend to hold a lower level of liquid assets, which indicates that using interest rate derivatives for the hedging purposes allows banks to substitute for their expensive liquidity. This result is consistent with the finding of Paligorova et al. (2014) who find that derivative hedgers are more likely to hold less cash to manage their balance sheet portfolios.

Then, I evaluate the impacts of interest rate derivatives usage for trading purposes on bank liquidity. The regression results for the baseline proxy of gross banks' derivatives usage for the trading purposes, *Gross IR Trading*, are reported in Table 4.3. In columns 1 and 2, the independent variable is *Liquidity Ratio*. The coefficient on *Gross IR Trading* is positive, but only statistically significant when the control variables are included. In columns 3 and 4, the alternative variable of liquidity, *Liquid Assets/TA*, is used. Similarly, the coefficient on *Gross IR Trading* is positive but only statistically significant in the specification with control variables, suggesting that the use of interest rate derivatives for the trading purposes does not reduce bank liquidity holding. This finding is consistent with Hypothesis 2.

In Table 4.4, I present the results of the aggregate interest rate derivative positions without considering its' holding purposes, *Gross IR Using*. The coefficients in all columns are positive, but only statistically significant at the 10% level in the specifications when control variables are included.

To summary, the empirical evidence in Tables 4.2 and 4.3 suggests that the substitution effect of the interest rate derivatives usage on bank liquidity only occurs when a bank holds interest rate derivatives for hedging purposes, while regarding the derivatives positions held for trading purposes, there is weak evidence that bank liquidity potentially increases. My findings highlight that only the interest rate derivatives held for hedging purposes can work as a substitute for liquidity in banking.

4.5.2 Alternative measures of interest rate derivatives usage

In Tables 4.5 and 4.6, I present the results by using alternative measures of the bank interest rate derivatives usage with different holding purposes, *Net IR Hedging* and/or *Net IR Trading*, to investigate how the use of interest rate derivatives for different purposes affects bank liquidity. The results of the alternative proxies of bank interest rate derivatives confirm the baseline results shown above.

In Table 4.5, I report the results when considering *Net IR Hedging* as the main independent variable. The coefficients on *Net IR Hedging* are negative and statistically significant in all specifications, which is consistent with the baseline results, showing that the use of interest rate derivatives for hedging purposes leads to lower liquidity in all columns. The results are identical to those when using *Gross IR Hedging* as a proxy of holding derivatives for hedging purposes, further supporting Hypothesis 1. Then, in Table 4.6, the results for the net interest rate derivative usage for trading purposes are reported. The coefficients of interest are statistically insignificant in all specifications. In short, the empirical results are consistent with my hypotheses, confirming that only the banks that hold interest rate derivative positions for hedging purposes reduce their liquidity positions. However, the impact of the interest rate derivatives usage for trading purposes and the aggregate usage of interest rate derivatives on bank liquidity is insignificant. My finding also provides a rationale for why splitting bank interest rate derivatives usage into different purposes is necessary.

4.5.3 Robustness

In this section, I provide several additional robustness tests. First, I control for the bank size by excluding the global systematically important banks, G-SIBs, in the sample and re-do the baseline regressions. This helps to relieve the too-big-to-fail concerns. I obtain the similar results shown in Table 4.7, which suggests that my results are not driven by the large banks.

In addition, I check on the robustness of the baseline results by re-doing the original regressions on the sample that contains only the banks that used the interest rate derivatives for hedging purposes during the sample period. I obtain the consistent results and report them in Table 4.8. All the coefficients of interest are identical in signs to the baseline regression results and remain statistically significant in most specifications.

4.5.4 Cross-sectional heterogeneity

In this section, I test for heterogeneity across the safer banks and riskier banks. Namely, I examine if safer banks reduce their liquidity holding more when they hold interest rate derivatives for the hedging purposes, compared to riskier banks. The ex-ante expectation is that the substitution effect of interest rate derivatives used for hedging purposes on bank liquidity holding would be stronger for safer banks since riskier banks face a higher insolvency risk and a relatively more binding liquidity requirement, and hence have fewer incentives to reduce their liquidity.

In order to test this hypothesis, I measure bank risks by calculating *Z-Score* for each bank, which measures the distance to default. A higher *Z-Score* signals that a bank has a lower insolvency risk and is safer. Then, I create an indicator variable, *Safer*, which takes the value 1 if the *Z-Score* for a bank is above the 50^{th} percentile, and zero otherwise. I then estimate an augmented version of Equation (4.4.2), which interacts the interest rate derivatives for hedging purposes, *Gross IR Hedging* (or *Net IR Hedging*), with the indicator variable, *Safer*. Specifically, I estimate the following regression:

$$Y_{i,t} = \beta_1 * IR\ Hedging_{i,t-1} + \lambda_1 * IR\ Hedging_{i,t-1} * Safer_i + \lambda_2 * Safer_i + \alpha X_{i,t-1} + \gamma_i + \gamma_t + \epsilon_{i,t} \quad (4.5.1)$$

The coefficient, λ_1, captures the heterogenous effect of safer banks. By itself, the coefficient, β_1, reflects the effects for riskier banks, while the sum, $\beta_1 + \lambda_1$, represents the effects for safer banks. I predict that λ_1 will take a same sign as β_1.

The results are reported in Table 4.9. For *Liquidity Ratio* and *Liquid Assets/TA* in the first two columns, the coefficient on *Gross IR Hedging* keeps negative and statistically significant. The coefficient, λ_1, on the interaction term, *Gross IR Hedging*Safer*, is negative and statistically significant in both columns, implying that the substitution effect is stronger for safer banks. Indeed, the sum of the two coefficients, $\beta_1 + \lambda_1$, is negative and statistically significant at the 1% level. In columns 3 and 4, the alternative measure of interest rate derivatives for hedging, *Net IR Hedging*, is used. The coefficient on *Net IR Hedging* is negative, but statistically insignificant. Consistent with the expectation, the coefficient on the interaction term is negative and statistically significant, confirming that the substitution effect is stronger for safer banks. Overall, the findings show that there is statistically evidence that the effect of interest rate derivatives for hedging purposes on substituting for liquidity holding is stronger for the safer banks, compared to the riskier banks. This finding is consistent with Elliot (2014), who states that all else equal, higher solvency banks have less need for liquidity.

4.6 Conclusion

Risk management has always been a priority for banks. Banks can manage their risks via on the balance sheet and off the balance sheet approaches both. Sound liquidity management, such as keeping a higher level of liquidity, provides banks with a cushion for financial shocks and reduces the likelihood of bankruptcy. However, banks incur higher opportunity costs when they hold too much liquidity. Banks should strike a balance between liquidity positions and profitability. Moreover, regarding the off-balance sheet approach, derivatives are suggested as an efficient and relatively low-cost risk management instrument for banks. Thus, the derivatives usage may work as a substitute for expensive liquidity to manage bank risks. However, whether and how the use of interest rate derivatives affects bank liquidity has been underexplored.

I examine how banks' use of interest rate derivatives impacts their liquidity, considering the different holding purposes of interest rate derivatives, by using the annual bank-level data during the 2012-2019 period. I provide empirical evidence that only the interest rate derivatives held for hedging purposes effectively decrease bank liquidity, which is consistent with the derivative-hedging hypothesis; while those interest rate derivatives for trading purposes do not reduce bank liquidity positions. My finding suggests that interest rate derivatives for the hedging purposes can be a substitute for holding liquidity in terms of risk management. I also find statistical evidence that this substitution effect is stronger for safer banks since riskier banks have more incentives to keep a higher level of liquidity due to the relatively binding liquidity requirement and their higher insolvency risks.

The key contribution of this chapter relates to the substitution effect of financial derivatives usage for hedging purposes on liquidity holding in banking. I hypothesise and confirm that only the interest rate derivatives for the hedging purposes can act as a substitute for liquidity in terms of bank risk management. The policy implications are important. Since the 2007-2009 financial crisis, the riskiness and complexity of financial derivatives have been concerned. However, my finding demonstrates that financial derivatives used for hedging purposes can benefit bank risk management by substituting expensive liquidity. Additionally, my finding indicates the importance of classifying financial derivatives usage according to its purposes.

This study has some limitations that could be further investigated in the future. First, due to data availability, I did not consider other derivatives with different purposes, e.g., credit derivatives, as the Call reports do not provide detailed information on them. Second, although I introduce a new variable, *Net IR Hedging*, to measure the net usage of interest rate derivatives for hedging purposes, this measurement is still imperfect. Therefore, future studies should try to construct a more perfect proxy to measure the use of interest rate derivatives for different purposes.

Furthermore, in order to further improve the coherence and interest of the story, in the next step, I would take an exogenous shock, which would have impacts on banks' balance sheet holdings. For example, from 2021 to today, inflation has changed a lot and caused a shock to banks' security holdings, which would add more bank risk-taking associated with higher inflation. From this exogenous shock, firstly, I will investigate whether the structure of new syndicated loans is affected by the increased inflation. Secondly, I will examine which banks are more vulnerable under the increased inflation shock and how these more vulnerable banks respond to the shock. Specifically, I will pay attention to whether the more vulnerable banks use more financial derivatives to respond to the shock compared to the less vulnerable banks; and whether their liquidity condition is improved as a result of the usage of financial derivatives under the inflation shock.

Table 4.1. **Descriptive statistics.**

The table shows the summary statistics of the key variables used in the analysis. All variables are winsorized at the 1^{st} and 99^{th} percentiles to minimize the effects of outliers.

Variable	N.	Mean	SD	p10	P25	P50	P75	P90
Liquidity Ratio	3,960	21.564	14.240	8.070	11.720	18.035	26.920	40.620
Liquid Assets/TA	3,961	19.163	12.475	7.210	10.460	16.020	24.050	36.200
Gross IR Hedging	3,806	4.300	17.219	0	0	0.518	3.310	11.268
Net IR Hedging	3,300	-1.110	36.997	-27.424	-0.323	0	0.847	21.265
Gross IR Trading	3,806	44.040	461.201	0	0	0	0	6.743
Net IR Trading	3,356	0.197	1.582	0	0	0	0	0
Gross IR Using	3,806	48.340	462.320	0	0	0.792	5.583	18.562
Size	3,806	14.793	1.590	13.310	13.691	14.287	15.440	16.916
GrowthTA	3,680	7.056	11.571	-2.675	1.045	4.655	9.530	18.885
ROA	3,756	0.963	0.636	0.380	0.670	0.930	1.210	1.600
Loan	3,806	64.047	14.444	44.780	56.930	66.410	74.100	79.73
Cash	3,806	1.789	1.061	0.690	1.140	1.600	2.170	2.980
Deposit	3,806	79.127	10.731	69.900	76.280	81.480	85.470	88.150
Equity	3,800	10.402	2.868	7.365	8.620	10.030	11.815	13.620
Overheads	3,756	3.188	1.558	2.070	2.480	2.910	3.420	4.170

Table 4.2. **Interest rate derivatives usage for hedging and bank liquidity holding.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Gross IR Hedging.* Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquidity Ratio	(3) Liquid Assets/TA	(4) Liquid Assets/TA
Gross IR Hedging	-0.049***	-0.026*	-0.043***	-0.021*
	(-2.81)	(-1.96)	(-2.72)	(-1.81)
Size		0.028		0.086
		(0.03)		(0.10)
GrowthSize		0.005		0.006
		(0.50)		(0.68)
Loan		-0.437***		-0.381***
		(-10.54)		(-10.75)
Equity		0.293*		0.138
		(1.86)		(1.05)
Overheads		-0.199		-0.221
		(-0.46)		(-0.56)
Cash		0.100		0.097
		(0.61)		(0.64)
ROA		0.135		0.077
		(0.58)		(0.38)
Deposit		0.201***		0.194***
		(3.44)		(3.71)
N	3,805	3,661	3,806	3,661
R^2	0.149	0.290	0.158	0.292
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.3. **Interest rate derivatives usage for trading and bank liquidity holding.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Gross IR Trading.* Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquidity Ratio	(3) Liquid Assets/TA	(4) Liquid Assets/TA
Gross IR Trading	0.005	0.005**	0.004	0.005**
	(1.17)	(2.14)	(1.16)	(2.05)
Size		0.106		0.170
		(0.10)		(0.19)
GrowthSize		0.005		0.006
		(0.47)		(0.64)
Loan		-0.435***		-0.379***
		(-10.48)		(-10.71)
Equity		0.301*		0.145
		(1.90)		(1.10)
Overheads		-0.245		-0.258
		(-0.57)		(-0.66)
Cash		0.096		0.092
		(0.58)		(0.61)
ROA		0.147		0.089
		(0.63)		(0.44)
Deposit		0.211***		0.202***
		(3.63)		(3.91)
N	3,805	3,661	3,806	3,661
R^2	0.147	0.290	0.157	0.293
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.4. **The aggregate interest rate derivatives usage and bank liquidity holding.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Gross IR Using*. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquidity Ratio	(3) Liquid Assets/TA	(4) Liquid Assets/TA
Gross IR Using	0.004	0.004*	0.004	0.004*
	(1.03)	(1.85)	(1.03)	(1.81)
Size		0.083		0.150
		(0.08)		(0.17)
GrowthSize		0.005		0.006
		(0.48)		(0.66)
Loan		-0.436***		-0.380***
		(-10.50)		(-10.73)
Equity		0.300*		0.145
		(1.90)		(1.10)
Overheads		-0.255		-0.268
		(-0.60)		(-0.69)
Cash		0.098		0.093
		(0.59)		(0.62)
ROA		0.143		0.086
		(0.61)		(0.43)
Deposit		0.212***		0.204***
		(3.65)		(3.93)
N	3,805	3,661	3,806	3,661
R^2	0.146	0.290	0.156	0.293
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.5. **An alternative measure of interest rate derivatives usage for hedging and bank liquidity holding.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Net IR Hedging.* Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquidity Ratio	(3) Liquid Assets/TA	(4) Liquid Assets/TA
Net IR Hedging	-0.015**	-0.011**	-0.013***	-0.010**
	(-2.59)	(-2.16)	(-2.67)	(-2.17)
Size		0.158		0.197
		(0.13)		(0.20)
GrowthSize		0.001		0.002
		(0.06)		(0.19)
Loan		-0.437***		-0.383***
		(-9.06)		(-9.31)
Equity		0.292		0.136
		(1.61)		(0.91)
Overheads		-0.042		-0.067
		(-0.09)		(-0.16)
Cash		0.170		0.157
		(0.87)		(0.89)
ROA		0.139		0.068
		(0.54)		(0.31)
Deposit		0.172***		0.166***
		(2.68)		(2.92)
N	3,300	3,106	3,300	3,106
R^2	0.135	0.275	0.141	0.276
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.6. **An alternative measure of interest rate derivatives usage for trading and bank liquidity holding.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Net IR Trading*. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquidity Ratio	(3) Liquid Assets/TA	(4) Liquid Assets/TA
Net IR Trading	-0.034	-0.056	-0.038	-0.056
	(-0.33)	(-0.65)	(-0.43)	(-0.72)
Size		-0.196		0.125
		(-0.16)		(-0.12)
GrowthSize		0.003		0.004
		(0.30)		(0.44)
Loan		-0.445***		-0.389***
		(-9.33)		(-9.60)
Equity		0.310*		0.153
		(1.69)		(1.01)
Overheads		-0.171		-0.187
		(-0.37)		(-0.44)
Cash		0.126		0.118
		(0.66)		(0.68)
ROA		0.066		0.002
		(0.26)		(0.01)
Deposit		0.209***		0.199***
		(3.13)		(3.37)
N	3,356	3,156	3,356	3,156
R^2	0.129	0.275	0.135	0.276
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.7. **Robustness tests after dropping the G-SIBs.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Gross IR Hedging* and *Net IR Hedging*, separately. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquid Assets/TA	(3) Liquidity Ratio	(4) Liquid Assets/TA
Gross IR Hedging	-0.026**	-0.022*		
	(-1.99)	(-1.84)		
Net IR Hedging			-0.012**	-0.011**
			(-2.39)	(-2.43)
Controls	Yes	Yes	Yes	Yes
N	3,594	3,594	3,040	3,040
R^2	0.291	0.294	0.277	0.279
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.8. **Robustness tests keeping only the banks which have used IR derivatives for hedging purposes.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The main variable of interest is *Gross IR Hedging* and *Net IR Hedging*, separately. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquid Assets/TA	(3) Liquidity Ratio	(4) Liquid Assets/TA
Gross IR Hedging	-0.022*	-0.019		
	(-1.72)	(-1.62)		
Net IR Hedging			-0.010*	-0.009*
			(-1.72)	(-1.69)
Controls	Yes	Yes	Yes	Yes
N	2,396	2,396	1,792	1,792
R^2	0.270	0.272	0.259	0.257
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Table 4.9. **Interest rate derivatives usage for hedging, bank liquidity holding, bank safety.**

The dependent variable is *Liquidity Ratio* and *Liquid Assets/TA*, respectively. The dependent variable is *Gross IR Hedging* and *Net IR Hedging*, separately. The interaction with the indicator variable of safer banks, *Safer*, is included. Control variables are lagged by one year. Bank fixed effects and year fixed effects are included in all regressions. The standard errors are clustered at the bank level. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

	(1) Liquidity Ratio	(2) Liquid Assets/TA	(3) Liquidity Ratio	(4) Liquid Assets/TA
Gross IR Hedging, β_1	-0.023*	-0.019*		
	(-1.90)	(-1.74)		
Gross IR Hedging*Safer, λ_1	-0.039*	-0.035*		
	(-1.84)	(-1.87)		
Net IR Hedging, β_1			-0.005	-0.004
			(-0.86)	(-0.78)
Net IR Hedging*Safer, λ_1			-0.012*	-0.011*
			(-1.84)	(-1.91)
Safer	0.221	0.188	0.260	0.218
	(1.00)	(0.95)	(0.98)	(0.93)
$\beta_1+\lambda_1$	-0.062**	-0.054**	-0.017***	-0.015***
	(-2.25)	(-2.20)	(-2.79)	(-2.82)
Controls	Yes	Yes	Yes	Yes
N	3,661	3,661	3,106	3,106
R^2	0.291	0.293	0.277	0.278
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Chapter 5

Conclusion

This thesis contributes with three independent chapters motivated by the increasing importance of banking in the financial market. This section summarizes the findings and contributions of this thesis and outlines relevant policy implications and research limitations.

In Chapter Two, we explore how banks deleverage in response to the (de facto) increase in capital requirements. Our identification relies on the implementation of the FAS 166/167 in 2010. After its implementation, banks were required to consolidate the securitized VIEs onto their balance sheets. Important for our identification, the consolidation itself did not directly have impacts on banks' risk exposures, since the banks were already exposed to most of the risk coming from these assets even before consolidation. We identify 36 treated banks which consolidated at least one VIE asset under the reforms between 2011 and 2015, and 62 securitizing banks that are larger than the smallest treated bank make up the control group in the final sample.

In response to the increase in capital requirements, on average, the treated banks de-lever by reducing risk-weighted assets (the denominator). In addition, the average impact is driven by the more opaque banks. We present a model which suggests that banks with opaque assets may face the adverse selection discount in selling their risky assets after they acquire private information about the quality of assets to explain this finding. Opaque banks avoid the adverse selection discount by selling their assets before gaining private information about the true value. Our results emphasise the role of informational asymmetry in bank assets to affect banks' response to an increased capital requirement.

We also provide a rationale for why some banks respond to an increased capital requirement, even if the requirements do not immediately bind.

The interaction effect of creditor participation rights and democracy on the cost of credit is explored in Chapter Three. Our empirical identification relies on the exogenous increases in the creditor participation index across seven countries during the sample period 2004-2014. We use the mean value of *Democracy* for a country to identify four countries as the high democratic countries, and three countries as the low democratic countries, among the seven treated countries.

We develop a hypothesis which predicts whether the effect of greater creditor participation on loan spreads differs depending on the democratic countries versus the relatively autocratic countries. By regressing an increase in creditor participation index on the cost of credit, *AISD*, in the high democratic and low democratic countries, respectively, we find that the higher creditor participation reduces loan spreads in the low democratic countries; while in the high democratic countries, there is no significant impact of the higher creditor participation on loan spreads. Our findings suggest that the effect of an increase in creditor participation right on reducing the cost of credit in low democratic countries is bigger than in high democratic countries. The novelty of this chapter is that our results imply that stronger creditor protection is more valuable in the low democratic countries. The two are substitutes. The policy implications are large: in countries with a lower level of democracy, greater creditor protection could benefit the cost of credit. However, similar creditor protection will be less effective in countries with a higher democratization.

Chapter Four examines whether and how interest rate derivatives usage can work as a substitute for liquidity in terms of bank risk management. By collecting the annual bank-level data between 2012 and 2019, we empirically investigate whether the use of interest rate derivatives can reduce liquidity holding in banking, depending on the different purposes for which derivatives are held. We find that only the interest rate derivatives for the hedging purposes significantly reduce bank liquidity; while for derivatives used for trading purposes, there is no significant impact on liquidity. Additionally, we find that the substitution effect of interest rate derivatives used for hedging on liquidity is stronger for safer banks.

The key contribution of this chapter is uncovering that the effect of financial derivatives on liquidity differs depending on the holding purposes, i.e., hedging versus trading. Only the use of interest rate derivatives for the hedging purposes can work as a substitute for liquidity to manage bank risk-taking. Our research contributes to the broad literature on bank risk management and financial derivatives usage.

Nevertheless, this study has a major limitation regarding bank derivatives data availability that could be investigated deeply in the future. The Call reports do not disclose detailed information about the holding purposes for some types of derivatives with different underlying assets, such as credit derivatives. In addition, there is no information on the trading direction for most derivative types. Although, we introduce a new variable, *Net IR Hedging*, this measurement is still an approximation. Therefore, future studies could try to further investigate the effects of financial derivatives by constructing a more accurate measurement to reflect financial derivatives usage.

Bibliography

Acemoglu, D., Naidu, S., Restrepo, P. & Robinson, J. A. (2019), 'Democracy does cause growth', *Journal of political economy* **127**(1), 47–100.

Acharya, V. V., Amihud, Y. & Litov, L. (2011), 'Creditor rights and corporate risk-taking', *Journal of financial Economics* **102**(1), 150–166.

Adrian, T. & Shin, H. S. (2010), 'Liquidity and leverage', *Journal of financial intermediation* **19**(3), 418–437.

Ahmed, R. (2021), 'A study on the impact of derivatives on bank risk and profitability', *Working paper* .

Alim, W., Ali, A. & Metla, M. R. (2021), 'The effect of liquidity risk management on financial performance of commercial banks in pakistan', *Working paper* .

Allen, F. & Carletti, E. (2008), 'Mark-to-market accounting and liquidity pricing', *Journal of accounting and economics* **45**(2-3), 358–378.

Allen, F., Carletti, E. & Marquez, R. (2015), 'Deposits and bank capital structure', *Journal of Financial Economics* **118**(3), 601–619.

Angrist, J. D. & Krueger, A. B. (1991), 'Does compulsory school attendance affect schooling and earnings?', *The Quarterly Journal of Economics* **106**(4), 979–1014.

Aretz, K., Bartram, S. M. & Dufey, G. (2007), 'Why hedge? rationales for corporate hedging and value implications', *The Journal of Risk Finance* **8**(5), 434–449.

Arner, D. W., Booth, C. D., Lejot, P. & Hsu, B. F. (2017), ‘Property rights, collateral, creditor rights, and insolvency in east asia’, *Commercial Law in East Asia* pp. 25–70.

Bae, K.-H. & Goyal, V. K. (2009), ‘Creditor rights, enforcement, and bank loans’, *The Journal of Finance* **64**(2), 823–860.

Baker, A. C., Larcker, D. F. & Wang, C. C. (2022), ‘How much should we trust staggered difference-in-differences estimates?’, *Journal of Financial Economics* **144**(2), 370–395.

Barton, J. (2001), ‘Does the use of financial derivatives affect earnings management decisions?’, *The Accounting Review* **76**(1), 1–26.

Bartram, S. M., Brown, G. W. & Conrad, J. (2011), ‘The effects of derivatives on firm risk and value’, *Journal of Financial and Quantitative Analysis* **46**(4), 967–999.

Beatty, A. & Liao, S. (2011), ‘Do delays in expected loss recognition affect banks’ willingness to lend?’, *Journal of accounting and economics* **52**(1), 1–20.

Beatty, A. & Liao, S. (2014), ‘Financial accounting in the banking industry: A review of the empirical literature’, *Journal of accounting and Economics* **58**(2-3), 339–383.

Begenau, J., Piazzesi, M. & Schneider, M. (2015), ‘Banks’ risk exposures’, *Working paper* .

Behr, P., Schmidt, R. H. & Xie, R. (2010), ‘Market structure, capital regulation and bank risk taking’, *Journal of Financial Services Research* **37**, 131–158.

Berger, A. N. & Bouwman, C. H. (2009), ‘Bank liquidity creation’, *The review of financial studies* **22**(9), 3779–3837.

Berger, A. N., Herring, R. J. & Szegö, G. P. (1995), ‘The role of capital in financial institutions’, *Journal of Banking and Finance* **19**(3-4), 393–430.

Berger, A. N. & Udell, G. F. (1994), ‘Did risk-based capital allocate bank credit and cause a ”credit crunch” in the united states?’, *Journal of Money, credit and Banking* **26**(3), 585–628.

Bessembinder, H. (1991), ‘Forward contracts and firm value: Investment incentive and contracting effects’, *Journal of Financial and quantitative Analysis* **26**(4), 519–532.

Bhattacharya, S. & Thakor, A. V. (1993), 'Contemporary banking theory', *Journal of financial Intermediation* **3**(1), 2–50.

Biswas, S. (2019), 'Creditor rights and the market power-stability relationship in banking', *Journal of Financial Stability* **40**, 53–63.

Biswas, S. & Koufopoulos, K. (2022), 'Bank capital structure and regulation: Overcoming and embracing adverse selection', *Journal of Financial Economics* **143**(3), 973–992.

Bliss, B. A., Clark, J. A. & DeLisle, R. J. (2018), 'Bank risk, financial stress, and bank derivative use', *Journal of Futures Markets* **38**(7), 804–821.

Bodie, Z. & Merton, R. C. (1998), 'A conceptual framework for analyzing the financial environment'.

Borusyak, K., Jaravel, X. & Spiess, J. (2021), 'Revisiting event study designs: Robust and efficient estimation', *Working paper* .

Bostandzic, D., Irresberger, F., Juelsrud, R. E. & Weiß, G. (2022), 'Do capital requirements make banks safer? evidence from a quasinatural experiment', *Journal of Financial and Quantitative Analysis* **57**(5), 1805–1833.

Bourke, P. (1989), 'Concentration and other determinants of bank profitability in europe, north america and australia', *Journal of Banking and Finance* **13**(1), 65–79.

Bouwman, C. H. (2013), 'Liquidity: How banks create it and how it should be regulated', *Working paper* .

Brewer, E., Minton, B. A. & Moser, J. T. (1996), 'Interest-rate derivatives and bank lending', *Working paper* .

Brewer III, E., Deshmukh, S. & Opiela, T. P. (2014), 'Interest-rate uncertainty, derivatives usage, and loan growth in bank holding companies', *Journal of financial Stability* **15**, 230–240.

Buffet, W. (2002), 'Warren buffet on derivatives'.

Buston, C. S. (2016), 'Active risk management and banking stability', *Journal of Banking and Finance* **72**, S203–S215.

Caglio, C., Darst, R. M. & Parolin, E. (2019), 'Half-full or half-empty? financial institutions, cds use, and corporate credit risk', *Journal of Financial Intermediation* **40**, 100812.

Callaway, B. & Sant'Anna, P. H. (2021), 'Difference-in-differences with multiple time periods', *Journal of econometrics* **225**(2), 200–230.

Campello, M., Lin, C., Ma, Y. & Zou, H. (2011), 'The real and financial implications of corporate hedging', *The journal of finance* **66**(5), 1615–1647.

Capelle-Blancard, G. (2010), 'Are derivatives dangerous? a literature survey', *International Economics* **123**, 67–89.

Casu, B., Clare, A., Sarkisyan, A. & Thomas, S. (2013), 'Securitization and bank performance', *Journal of money, credit and banking* **45**(8), 1617–1658.

Chance, D. M. & Brooks, R. (2015), *Introduction to derivatives and risk management*, Cengage Learning.

Chang, C.-C., Ho, K.-Y. & Hsiao, Y.-J. (2018), 'Derivatives usage for banking industry: evidence from the european markets', *Review of Quantitative Finance and Accounting* **51**, 921–941.

Chaudhry, D. N., Mehmood, M. S. & Mehmood, A. (2014), 'Determinants of corporate hedging policies and derivatives usage in risk management practices of non-financial firms', *Wulfenia Journal, ISI Indexed, Impact Factor 0.267* **21**(7), 293–310.

Chava, S. & Roberts, M. R. (2008), 'How does financing impact investment? the role of debt covenants', *The journal of finance* **63**(5), 2085–2121.

Cornett, M. M., McNutt, J. J., Strahan, P. E. & Tehranian, H. (2011), 'Liquidity risk management and credit supply in the financial crisis', *Journal of financial economics* **101**(2), 297–312.

Corona, C., Nan, L. & Zhang, G. (2015), 'Accounting information quality, interbank competition, and bank risk-taking', *The Accounting Review* **90**(3), 967–985.

Cyree, K. B., Huang, P. & Lindley, J. T. (2012), 'The economic consequences of banks' derivatives use in good times and bad times', *Journal of Financial Services Research* **41**, 121–144.

Dang, T. V., Gorton, G., Holmström, B. & Ordonez, G. (2017), 'Banks as secret keepers', *American Economic Review* **107**(4), 1005–1029.

Dávila, E. & Hébert, B. (2023), 'Optimal corporate taxation under financial frictions', *The Review of Economic Studies* **90**(4), 1893–1933.

De Chaisemartin, C. & d'Haultfoeuille, X. (2020), 'Two-way fixed effects estimators with heterogeneous treatment effects', *American Economic Review* **110**(9), 2964–2996.

De Jonghe, O., Dewachter, H. & Ongena, S. (2020), 'Bank capital (requirements) and credit supply: Evidence from pillar 2 decisions', *Journal of Corporate Finance* **60**.

Delis, M. D., Hasan, I. & Ongena, S. (2020), 'Democracy and credit', *Journal of Financial Economics* **136**(2), 571–596.

DeMarzo, P. M. & Duffie, D. (1995), 'Corporate incentives for hedging and hedge accounting', *The review of financial studies* **8**(3), 743–771.

Demirguc, A., Laeven, L. & Levine, R. (2003), 'The impact of bank regulations, concentration, and institutions on bank margins', *Working paper* .

Deng, S., Elyasiani, E. & Mao, C. X. (2017), 'Derivatives-hedging, risk allocation and the cost of debt: Evidence from bank holding companies', *The Quarterly Review of Economics and Finance* **65**, 114–127.

Dewally, M. & Shao, Y. (2013), 'Financial derivatives, opacity, and crash risk: Evidence from large us banks', *Journal of Financial Stability* **9**(4), 565–577.

Diamond, D. W. (1984), 'Financial intermediation and delegated monitoring', *The review of economic studies* **51**(3), 393–414.

Diamond, D. W. & Kashyap, A. K. (2016), 'Liquidity requirements, liquidity choice, and financial stability', *Handbook of macroeconomics* **2**, 2263–2303.

Djankov, S., McLiesh, C. & Shleifer, A. (2007), 'Private credit in 129 countries', *Journal of financial Economics* **84**(2), 299–329.

Dou, Y. (2021), 'The spillover effect of consolidating securitization entities on small business lending', *The Accounting Review* **96**(5), 207–229.

Dou, Y., Ryan, S. G. & Xie, B. (2018), 'The real effects of FAS 166/167 on banks' mortgage approval and sale decisions', *Journal of Accounting Research* **56**(3), 843–882.

Drehmann, M. & Nikolaou, K. (2013), 'Funding liquidity risk: definition and measurement', *Journal of Banking and Finance* **37**(7), 2173–2182.

Duffee, G. R. & Zhou, C. (2001), 'Credit derivatives in banking: Useful tools for managing risk?', *Journal of Monetary Economics* **48**(1), 25–54.

Eckley, P., Francis, W. & Mathur, A. (2019), 'In the dangerzone! regulatory uncertainty and voluntary bank capital surpluses', *Working paper* .

Elliot, D. J. (2014), 'Bank liquidity requirements: An introduction and overview', *Working paper* .

Elliott, W. B., Huffman, S. P. & Makar, S. D. (2003), 'Foreign-denominated debt and foreign currency derivatives: complements or substitutes in hedging foreign currency risk?', *Journal of Multinational Financial Management* **13**(2), 123–139.

Esty, B. C. & Megginson, W. L. (2003), 'Creditor rights, enforcement, and debt ownership structure: Evidence from the global syndicated loan market', *Journal of financial and quantitative analysis* **38**(1), 37–60.

Fiedor, P. & Killeen, N. (2021), 'Securitisation special purpose entities, bank sponsors and derivatives', *Journal of International Financial Markets, Institutions and Money* **75**, 101452.

Fraisse, H., Lé, M. & Thesmar, D. (2020), 'The real effects of bank capital requirements', *Management Science* **66**(1), 5–23.

Froot, K. A., Scharfstein, D. S. & Stein, J. C. (1993), 'Risk management: Coordinating corporate investment and financing policies', *the Journal of Finance* **48**(5), 1629–1658.

Gardner, J. (2022), 'Two-stage differences in differences', *Working paper* .

Gilkeson, J. & Smith, S. (2006), 'The impact of derivatives on commercial banks (2000–2004)', *Working paper* .

Gorton, G. & Pennacchi, G. (1995), 'Banks and loan sales: marketing non-marketable assets', *Working paper* .

Greenspan, A. (2004), 'Economic flexibility, speech to hm treasury enterprise conference'.

Greenwood, R., Landier, A. & Thesmar, D. (2015), 'Vulnerable banks', *Journal of Financial Economics* **115**(3), 471–485.

Gropp, R., Mosk, T., Ongena, S., Simac, I. & Wix, C. (2021), 'Supranational rules, national discretion: Increasing versus inflating regulatory bank capital?', *Journal of Financial and Quantitative Analysis* pp. 1–58.

Gropp, R., Mosk, T., Ongena, S. & Wix, C. (2019), 'Banks response to higher capital requirements: Evidence from a quasi-natural experiment', *The Review of Financial Studies* **32**(1), 266–299.

Guay, W. R. (1999), 'The impact of derivatives on firm risk: An empirical examination of new derivative users', *Journal of Accounting and Economics* **26**(1-3), 319–351.

Hakimi, A. & Zaghdoudi, K. (2017), 'Liquidity risk and bank performance: An empirical test for tunisian banks', *Business and Economic Research* **7**(1), 46–57.

Hanson, S. G., Shleifer, A., Stein, J. C. & Vishny, R. W. (2015), 'Banks as patient fixed-income investors', *Journal of Financial Economics* **117**(3), 449–469.

Hasan, I., Hoi, C. K. S., Wu, Q. & Zhang, H. (2014), 'Beauty is in the eye of the beholder: The effect of corporate tax avoidance on the cost of bank loans', *Journal of financial economics* **113**(1), 109–130.

Hasan, I., Park, J. C. & Wu, Q. (2012), 'The impact of earnings predictability on bank loan contracting', *Journal of Business Finance and Accounting* **39**(7-8), 1068–1101.

Haselmann, R., Pistor, K. & Vig, V. (2010), 'How law affects lending', *The Review of Financial Studies* **23**(2), 549–580.

Hendricks, B. E., Neilson, J. J., Shakespeare, C. & Williams, C. D. (2023), 'Anticipatory effects around proposed regulation: Evidence from Basel III', *The Accounting Review* **98**(1), 285–315.

Hentschel, L. & Kothari, S. P. (2001), 'Are corporations reducing or taking risks with derivatives?', *Journal of financial and quantitative analysis* **36**(1), 93–118.

Hirtle, B. J. (1997), 'Derivatives, portfolio composition, and bank holding company interest rate risk exposure', *Journal of Financial Services Research* **12**(2-3), 243–266.

Horváth, R., Seidler, J. & Weill, L. (2014), 'Bank capital and liquidity creation: Granger-causality evidence', *Journal of Financial Services Research* **45**, 341–361.

Houston, J. F., Lin, C., Lin, P. & Ma, Y. (2010), 'Creditor rights, information sharing, and bank risk taking', *Journal of financial Economics* **96**(3), 485–512.

Imbierowicz, B., Kragh, J. & Rangvid, J. (2018), 'Time-varying capital requirements and disclosure rules: Effects on capitalization and lending decisions', *Journal of Money, Credit and Banking* **50**(4), 573–602.

Ivashina, V. (2009), 'Asymmetric information effects on loan spreads', *Journal of financial Economics* **92**(2), 300–319.

Jayaraman, S. & Thakor, A. V. (2014), 'Who monitors the monitor? bank capital structure and borrower monitoring', *Working paper* .

Jokipii, T. & Milne, A. (2008), 'The cyclical behaviour of european bank capital buffers', *Journal of banking and finance* **32**(8), 1440–1451.

Kashyap, A. K., Rajan, R. & Stein, J. C. (2002), 'Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking', *The Journal of finance* **57**(1), 33–73.

La Porta, R., Lopez-de Silanes, F., Shleifer, A. & Vishny, R. W. (1997), 'Legal determinants of external finance', *The journal of finance* **52**(3), 1131–1150.

La Porta, R., Lopez-de Silanes, F., Shleifer, A. & Vishny, R. W. (1998), 'Law and finance', *Journal of political economy* **106**(6), 1113–1155.

Laeven, L. & Levine, R. (2009), 'Bank governance, regulation and risk taking', *Journal of financial economics* **93**(2), 259–275.

Lartey, V. C., Antwi, S. & Boadi, E. K. (2013), 'The relationship between liquidity and profitability of listed banks in ghana', *International journal of business and social science* **4**(3), 48–56.

Li, S. & Marinč, M. (2014), 'The use of financial derivatives and risks of us bank holding companies', *International Review of Financial Analysis* **35**, 46–71.

Lindquist, K.-G. (2004), 'Banks' buffer capital: how important is risk', *Journal of International Money and Finance* **23**(3), 493–513.

Mamatzakis, E. & Bermpei, T. (2014), 'What drives investment bank performance? the role of risk, liquidity and fees prior to and during the crisis', *International Review of Financial Analysis* **35**, 102–117.

Mayordomo, S., Rodriguez-Moreno, M. & Peña, J. I. (2014), 'Derivatives holdings and systemic risk in the us banking sector', *Journal of Banking and Finance* **45**, 84–104.

Miller, D. P. & Reisel, N. (2012), 'Do country-level investor protections affect security-level contract design? evidence from foreign bond covenants', *The Review of Financial Studies* **25**(2), 408–438.

Minton, B. A., Stulz, R. & Williamson, R. (2009), 'How much do banks use credit derivatives to hedge loans?', *Journal of Financial Services Research* **35**, 1–31.

Modigliani, F. & Miller, M. H. (1958), 'The cost of capital, corporation finance and the theory of investment', *The American economic review* **48**(3), 261–297.

Molyneux, P. & Thornton, J. (1992), 'Determinants of european bank profitability: A note', *Journal of banking and Finance* **16**(6), 1173–1178.

Moulton, B. R. (1990), 'An illustration of a pitfall in estimating the effects of aggregate variables on micro units', *The review of Economics and Statistics* pp. 334–338.

Nance, D. R., Smith Jr, C. W. & Smithson, C. W. (1993), 'On the determinants of corporate hedging', *The journal of Finance* **48**(1), 267–284.

Nguyen, H. & Faff, R. (2010), 'Are firms hedging or speculating? the relationship between financial derivatives and firm risk', *Applied Financial Economics* **20**(10), 827–843.

Olson, M. (2000), 'Power and prosperity: Outgrowing communist and capitalist dictatorships'.

Osei-Tutu, F. & Weill, L. (2020), 'Does access to credit come with access to voting? democracy and firm financing constraints', *Working paper* .

Paligorova, T., Staskow, R. et al. (2014), 'The use of financial derivatives by canadian firms', *Bank of Canada Review* **2014**(Autumn), 47–54.

Papaioannou, E. & Siourounis, G. (2008), 'Democratisation and growth', *The Economic Journal* **118**(532), 1520–1551.

Parlour, C. A. & Plantin, G. (2008), 'Loan sales and relationship banking', *The Journal of Finance* **63**(3), 1291–1314.

Pasiouras, F. & Kosmidou, K. (2007), 'Factors influencing the profitability of domestic and foreign commercial banks in the european union', *Research in international business and finance* **21**(2), 222–237.

Qian, J. & Strahan, P. E. (2007), 'How laws and institutions shape financial contracts: The case of bank loans', *The Journal of Finance* **62**(6), 2803–2834.

Rajan, R. & Zingales, L. (1996), 'Financial dependence and growth'.

Ratnovski, L. (2013), 'Liquidity and transparency in bank risk management', *Journal of Financial Intermediation* **22**(3), 422–439.

Rodrik, D. & Wacziarg, R. (2005), 'Do democratic transitions produce bad economic outcomes?', *American Economic Review* **95**(2), 50–55.

Roengpitya, R., Tarashev, N. A. & Tsatsaronis, K. (2014), 'Bank business models', *BIS quarterly review December* .

Roth, J., Sant'Anna, P. H., Bilinski, A. & Poe, J. (2023), 'What's trending in difference-in-differences? a synthesis of the recent econometrics literature', *Journal of Econometrics* .

Shanker, L. (1996), 'Derivatives usage and interest rate risk of large banking firms', *The Journal of Futures Markets* **16**(4), 459.

Shleifer, A. & Vishny, R. (2011), 'Fire sales in finance and macroeconomics', *Journal of economic perspectives* **25**(1), 29–48.

Shleifer, A. & Vishny, R. W. (1992), 'Liquidation values and debt capacity: A market equilibrium approach', *The journal of finance* **47**(4), 1343–1366.

Simons, K. (1993), 'Why do banks syndicate loans?', *New England Economic Review* (Jan), 45–52.

Sinkey Jr, J. F. & Carter, D. A. (2000), 'Evidence on the financial characteristics of banks that do and do not use derivatives', *The quarterly review of economics and finance* **40**(4), 431–449.

Smith, C. W. & Stulz, R. M. (1985), 'The determinants of firms' hedging policies', *Journal of financial and quantitative analysis* **20**(4), 391–405.

Stolz, S. & Wedow, M. (2011), 'Banks' regulatory capital buffer and the business cycle: Evidence for germany', *Journal of Financial Stability* **7**(2), 98–110.

Sun, L. & Abraham, S. (2021), 'Estimating dynamic treatment effects in event studies with heterogeneous treatment effects', *Journal of Econometrics* **225**(2), 175–199.

Sundaram, S. & Willey, T. (2009), 'Derivatives activity by us banks: Impact on risk and profitability', *Working paper* .

Tang, H. (2019), 'Peer-to-peer lenders versus banks: substitutes or complements?', *The Review of Financial Studies* **32**(5), 1900–1938.

Tian, X. & Zhang, H. (2016), 'Impact of FAS 166/167 on credit card securitization', *Working paper* .

Trapp, R. & Weiß, G. N. (2016), 'Derivatives usage, securitization, and the crash sensitivity of bank stocks', *Journal of Banking and Finance* **71**, 183–205.

Venkatachalam, M. (1996), 'Value-relevance of banks' derivatives disclosures', *Journal of Accounting and Economics* **22**(1-3), 327–355.

Vodova, P. (2011), 'Liquidity of czech commercial banks and its determinants', *International Journal of mathematical models and methods in applied sciences* **5**(6), 1060–1067.

Yang, D.-H., Song, I., Yi, J. & Yoon, Y.-H. (2006), 'Effects of derivatives on bank risk', *Review of Pacific Basin Financial Markets and Policies* **9**(02), 275–295.