Titel der Arbeit: “Four Essays on Financial Stability and Competition with Heterogeneous Banks.”

Schriftliche Promotionsleistung
zur Erlangung des akademischen Grades
Doctor rerum politicarum

vorgelegt und angenommen
an der Fakultät für Wirtschaftswissenschaft
der Otto-von-Guericke-Universität Magdeburg

Verfasserin: Carola Müller
Geburtsdatum und -ort: 25.08.1986, Wolfenbüttel
Arbeit eingereicht am: 01.03.2018

Gutachter der schriftlichen Promotionsleistung:
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Datum der Disputation: 02.05.2018

Otto-von-Guericke University
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Doctoral Thesis

Four Essays on

Financial Stability and Competition with Heterogeneous Banks

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March 01, 2018

Acknowledgements

First and foremost, I would like to thank Felix Noth and Michael Koetter for their invaluable support, advise and guidance. I am honored to have them as my co-authors and supervisors. I am grateful to Felix Noth for having all the answers and always finding the time to share them with me, for giving me his advice and feedback when I needed it, and for balancing me on numerous occasions with his kind encouragement, trust, and unrelenting positivity. I am grateful to Michael Koetter for his extraordinary willingness to share his network with me, especially by pointing out the opportunity to me to collaborate in a project with Deutsche Bundesbank, and his genuine interest in my ideas and academic development.

I am honored that Reint Gropp would agree to serve on the committee and review this thesis. In his capacity as the president of the Halle Institute for Economic Research I owe him for providing funding for this dissertation project which allowed me to focus on my research without major distractions during the last two and a half years.

I thank Hans-Peter Burghof for supervising me at the University of Hohenheim and I owe him special thanks for introducing me to the research field of banking regulation. I am grateful to him for the funding he provided during my time in Hohenheim and his open-mindedness to allow me developing my own research agenda. I am fortunate to work with him as co-author in the paper on which Chapter 4 is based.

I thank Benedikt Fritz for his collaboration as my co-author in the paper on which Chapter 3 is based and Ulrich Krüger for hosting me as a guest researcher in the Directorate General Financial Stability at Deutsche Bundesbank. Their comments and advise advanced my work and me personally.

I am indebted to my colleagues Manuel Buchholz, Steffen Kirsch, Thomas Krause, Oliver Rehbein, and Qizhou Xiong for their valuable advise, comments, support and cooperation. I like to extend my gratitude to my fellow PhD students, colleagues in the Financial Markets Department at IWH, and colleagues at the Chair of Banking and Financial Services at University of Hohenheim. Special thanks go to my roommates, Kirsten and Helge, for illuminating my humor in one of the sunniest offices in Halle. Conversations, coffee breaks, lunches, and walks with Carolin and Marlis, Chris and Matias, as well as Eva, Gerold, Julius, Konstantin, and Lisa contributed in their own immeasurable way to the completion of this thesis.

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To my father.

Chapter 1

Preface and outline of the thesis

Finding the proper balance between state and market is challenging. Especially in banking (Stiglitz, 1993). Banks in their function as financial intermediaries are risky and inherently prone to failure (Diamond and Dybvig, 1983; Diamond, 1984). But they provide services of vital importance to the economy in the form of payment services, credit supply for investments, inter-temporal liquidity transformation, or management of savings accounts. Consequently, the stability of the banking and financial sector is of public interest. In the least, the financial crisis was an unpleasant reminder to the industrialized world about the severe repercussions of unstable banking systems.

The financial crisis revealed risks in the banking market whose causes lay well outside the scope of mere intermediation (Basel Committee on Banking Supervision, 2010). Banks accumulated large off-balance sheet exposures, partly in an unregulated shadow banking sector. Compared to the risks that these exposures involved, they held insufficient capital and liquidity buffers. On top they were exposed to systemic risks that cannot be attributed to the decisions of single institutions. Within the network of interbank transactions, some institutions turned out to be too-interconnected-to-fail or too-big-to-fail. Common exposures among banks led to procyclical deleveraging and firesales which aggravated liquidity shortages.

In response, the regulatory framework was revised and augmented. In this vain, capital and liquidity standards were tightened, and macroprudential policies were introduced to address systemic risk. Emergency measures were taken in the form of bail-outs, nationalizations, and guarantees. But not only since the financial crisis, the banking industry has a high share of sovereign intervention compared to other industries. Over 80% of high-income countries around the world have a deposit insurance scheme in place (Demirgüç-Kunt et al., 2014). Since deposit insurance creates a moral hazard problem, it is reasonable to complement it with other regulatory measures, such as risk-adjusted capital requirements or insurance premia (Rochet, 1992). In many countries governments themselves provide banking services through government-owned banks (La Porta et al., 2002).

In the interest of financial stability, public authorities use these various instruments to own or manage bank risks. The evaluation of the need for banking regulation and its use is constantly on the agenda of researchers and policy makers alike. Measures are not only evaluated with respect to their efficacy in enhancing financial stability but also with respect to economic efficiency. Efficient banking and financial markets channel funds to their best use in the real economy and distribute resources to those institutions with the highest productivity. In the absence of market power and externalities[1], the market is considered the best mechanism to ensure an efficient allocation (Maskin, 2008). Any interference with free markets and open competition could therefore result in less efficient outcomes. Thus, economic efficiency and financial stability can be competing objectives.

Any assessment of this trade-off, as the present analysis, is complicated by the debate whether competition and productivity themselves might not be associated with risk. A lack of competition can be a source of market power for banks and thus create a positive charter value. Opposing views argue that either banks protect such charter value by taking less risks (*competition-fragility view*) or banks use it as a complement to equity capital and thus take more risks in order to optimize return (*competition-stability view*). Having a productivity advantage over competitors can similarly constitute a positive charter value for a bank. Accordingly, banks with high productivity might be inclined to secure their superior production technology by engaging in less risky activities (*charter value hypothesis*) or they exploit it and become riskier (*efficiency-risk hypothesis*). In the end, politicians and regulatory authorities must take a stance in order to design sound policies and find the right balance since empirical evidence and theoretical arguments underpin either hypothesis.

This thesis contributes empirical as well as theoretical results to the discussion by studying the role of competition and governmental intervention in risk-taking and economic efficiency. In particular, the empirical analysis in Chapter 2 studies whether banks protected their charter values in the U.S. mortgage market, where the crisis originated, by exerting more screening efforts and engaging in less risky mortgages. The thesis continues in Chapter 3 with an empirical study that investigates the effect of governmental involvement in the competitive environment, especially in a situation where political protection impedes takeovers and exit mechanisms, on the efficient allocation of resources among banks. Chapters 4 and 5 study consequences of the interaction of risk-sensitive capital requirements and a leverage ratio, which was introduced by the Basel III accord, in a theoretical setting. In Chapter 4 it is pointed out that the interaction of both competing capital requirements might put diversified banks at a disadvantage and increase systemic risk in the form of assimilation of business models resulting in a less diverse banking system. Finally, Chapter 5 encompasses an approach to combine regulation, risk, competition, and efficiency. It studies whether regulation effectively limits risk and allows for an efficient allocation of resources in an imperfect competitive environment with heterogeneous banks.

In Chapter 2 we assess the relationship between competition and risk. We focus on banks' risk-taking behavior in the U.S. mortgage market in the decade preceding the crisis, i.e., on the time and place where the global financial crisis originated. The driving forces behind the crisis in the subprime mortgage market are seen in an expansion of credit supply which was not backed by economic fundamentals (Mian and Sufi, 2009) and

[1]In banking, however, the role of asymmetric information and limited liability give rise to situations where the market is not able to ensure the efficient solution. Consider, e.g., market power due to informational lock-in (Sharpe, 1990; Von Thadden, 2004), credit rationing (Stiglitz and Weiss, 1981), or externalities in the form of systemic risks mentioned above.

in the increasing use of securitization (Keys et al., 2010). But not much attention was shed on the role of competition. We investigate the effect of market power and information on banks' presumably insufficient risk screening activities using loan application data from the Home Mortgage Disclosure Act (HMDA) in the years 1995 to 2005. We find that banks with more market power issue mortgage loans with lower Loan-to-Income Ratios, i.e., less risky loans because the Loan-to-Income Ratio should capture a borrower's ability to repay. Since assessing the riskiness of a mortgage depends on knowledge about the region as well as the borrower, we further show that the risk-mitigating effect of market power is stronger for banks that are better informed because they are closer located to the respective market, operate branches there or have at least three years experience in the market.

Our findings support the *competition-fragility view* which states that banks with market power protect their charter value by taking less risks. In combination with the results from Favara and Imbs (2015) who show that especially banks that entered new markets after deregulation expanded credit supply and spurred house price growth, this sheds an unfavorable light on the liberalization of banking competition in the U.S. during that time. Evidence by Stiroh and Strahan (2003), however, shows that industry dynamics after the deregulation induced a reallocation of market shares toward more productive banks. This suggests that U.S. branching deregulation laws might be an example of the aforementioned trade-off between economic efficiency and financial stability.

The analysis in Chapter 3 aims to detect inefficiencies due to disfunctioning industry dynamics in order to underline the importance of competition to ensure that unproductive banks ultimately exit the market. We make use of the regulation for German government-owned savings banks, which exempts these from hostile takeovers through any other bank, thus leaving the decision about bank mergers in the hands of local politicians who govern the savings banks. We conjecture that such a setting would not lead to the efficient allocation of resources. Making use of exogenous shocks in the form of county reforms between 1993 and 2013 which forced savings banks to merge, we find that these reform-induced mergers unleashed both banks' and firms' potential. In particular, we find that these mergers enhanced banks' profitability but also led to riskier financial profiles of banks and that local firms connected to these banks received lower financing costs and realized higher investment and employment.

The German government-owned banking sector has a long history and is often justified by its procurement of banking services in rural areas. While our analysis cannot judge whether private markets would fail in supplying services ubiquitously, it points to the intricacies of the involvement of the state in the governance of otherwise competing institutions. Banks with politically motivated management can have different objectives than privately managed banks and our results show that optimizing the organizational structure might not have priority among them.

Nevertheless, the financial crisis shifted the balance in favor of state interventions which led to a revision in the global regulatory framework under the guidance of the Basel Committee of Banking Supervision. Under the Basel III accord capital requirements, which are the main quantitative tool used in Pillar I, were severely tightened. Among the new rules is the leverage ratio which is the subject of inquiry in Chapters 4 and 5. In contrast to other requirements, the leverage ratio does not adhere to the paradigm of risk-sensitivity of capital regulation. It is a well known criticism that such a simple equity-to-assets ratio sets incentives for banks to become riskier (Kahane, 1977; Kim and Santomero, 1988). This raises the question whether the combination of a simple and a risk-adjusted ratio can effectively limit risk-taking. Furthermore, the multiplicity of new regulatory measures calls for an evaluation of interaction effects between them.

In Chapter 4 we analyze how the portfolio choice of a single representative bank is affected when it is simultaneously regulated by a leverage ratio and a value-at-risk requirement. Value-at-risk requirements are used, for example, in the assessment of market risks in bank portfolios. They factor the benefits of diversification in and therefore set incentives to hold mixed portfolios even if a bank has a comparative advantage for managing certain assets. We show that with a leverage ratio especially banks with well diversified portfolios are affected and have to specialize more as a reaction. When we assume that all banks react similarly, this implies that the leverage ratio induces an assimilation of business models which results in a less diverse banking market. If banks hold correlated asset portfolios, the market is less resilient to adverse shocks which would then affect all banks alike (Wagner, 2010).

However, this approach does not take into account how competition affects banks' choices and does not derive a market equilibrium. The model in Chapter 5 remedies these points and studies the interaction between the leverage ratio and a risk-weighted ratio with heterogeneous banks in competition. Different from the preceding chapter, the risk-weighted ratio studied here is additive, as in common models used to assess capital charges for credit risks. I extend a portfolio choice model by adding heterogeneity in productivity among banks. Banks choose their strategy in a high-risk and a low-risk credit market with Cournot competition. In this vain, this thesis also contributes methodologically, since only few theoretical models in banking regulation take heterogeneity into account so far (VanHoose, 2007), and to the best of the author's knowledge it is the first to do so in an Industrial Organization context. I find that risk-weighted requirements incentivize banks with high productivity to lend to low-risk firms. When a leverage ratio is introduced, these banks lose market shares to less productive competitors and react with risk-shifting into high-risk loans. However, this higher share of high-risk loans does not increase their default probabilities, at least not as long as systematic risk is moderate. While average productivity in the low-risk market falls, market shares in the high-risk market are dispersed across new entrants with high as well as low productivity. Compared to the situation under Basel II regulation where high-risk exposures were concentrated on low-productivity lenders, the wider dispersion of market shares can be seen as a positive side effect of the introduction of the leverage ratio. Overall, however, average productivity in the banking market would fall.

The models in Chapters 4 and 5 show that competing capital requirements inadvertently favor some banks over others. A regulator should therefore consider whether those banks that are targeted by a leverage ratio share underlying characteristics which induces them to be highly levered. As the models point out, these might be positive traits, such as having a high productivity or being well diversified. These might also be negative features, such as gambling for resurrection or facing high competitive pressure. Either way, if there are systematic differences, it can affect the efficacy of the leverage ratio in making the banking system more resilient.

The dissertation is structured as follows. Chapters 2 to 5 represent the four research papers that conform the main part of the dissertation. Complementing the general contribution of the dissertation outlined in this introduction, each chapter carefully addresses its individual contribution to the literature. A general conclusion is drawn in Chapter 6.

Chapter 2

Market power and risk: Evidence from the U.S. mortgage market *

Abstract: *The turmoil in the U.S. mortgage market marks the starting point of the global financial crisis. We shed light on the role of banks' market power on their presumably insufficient risk screening activities in the pre-crisis era. We use mortgage loan application data of the Home Mortgage Disclosure Act (HMDA) in the years 1995 to 2005. We find that banks with higher market power accept applications with lower loan-to-income ratios. Having more information about local markets tends to aggravate the risk-mitigating effect of market power. The effect gets weaker as the distance between regional mortgage markets and banks' headquarters grows or if banks enter a new market, whereas it gets stronger if banks have local branches.*

2.1 Introduction

Recent findings by Akins et al. (2016) show that higher competition in form of less concentrated deposit markets comes with less risky behavior of banks in mortgage business. This points against studies supporting the charter value paradigm in banking (Keeley, 1990) that show that banks in less competitive markets care about preserving their charter and thereby take less risks.

In this vein, our paper tests in detail whether and how banks' market power affects risk-taking in the form of Loan-to-Income Ratios in regional U.S. mortgage markets in the run-up to the financial crisis of 2007/09. At odds with Akins et al. (2016) our results point towards the classic charter value paradigm since we show that banks with higher market power issue mortgage loans with significantly lower Loan-to-Income Ratios. We further show that relationship banking factors like distance to customer and market information play a significant role in the transmission of market power on risk-taking. We find that the market power effect is stronger if banks have more information about the market and are closer located to their customers. Thereby, our results also show that market power together with information generation was a factor for banks before 2007 in order to engage in less risky mortgage activities.

*This chapter is co-authored by Felix Noth, Halle Institute for Economic Research, Otto-von-Guericke University Magdeburg (Contact: *felix.noth@iwh-halle.de*).

2.2 Data

We use mortgage loan application data for the years 1994 to 2005 reported under the Home Mortgage Disclosure Act (HMDA) which covers approximately over 90% of the U.S. mortgage market (Dell'Ariccia et al., 2012). The HMDA requires lenders to report on a yearly basis all received loan applications with information about the loan, the underlying property including its location, and the borrower. We exclude applications that are guaranteed by any federal agency because they are unlikely to reflect banks' choice of risk-taking. We use only applications for the purpose of home purchase.

In order to delineate regional mortgage markets we use 380 Metropolitan Statistical Areas (MSAs).[1] We aggregate the loan application data then at the MSA-level for each reporting institution in each year. We obtain information about the reporting institution by the HMDA lender file provided by Robert Avery (Avery et al., 2007). Further, we restrict the sample to depository institutions and thereby exclude independent mortgage companies that have an average market share of 24%. We match Statistics on Depository Institutions and the Summary of Deposits provided by the Federal Deposit Insurance Corporation to obtain accounting data and bank branch locations. This way, we exclude credit unions which account on average only for 2% of the mortgage market.

The final sample consists of 6,065 commercial banks and 1,547 thrifts. Half of these banks offer mortgage loans in no more than 4 regional markets, and only 2% of banks serve more than half of all MSAs. Regional markets are characterized by a high number of competitors but unequal distribution of market shares. On average 332 banks and 126 mortgage companies compete in each mortgage market while the top 3 institutions among them account for about 20% of the mortgage business.

2.3 Methodology

To assess the impact of U.S. banks' market power on their risk-taking in the mortgage market, we exploit the regional dispersion of mortgage business to compare risk-taking of banks with different degrees of market power in the same region by estimating

$$\text{Risk}_{i,t,m} = \alpha_i + \beta \text{ Market Power}_{i,t} + \gamma_1 \mathbf{X}_{i,t} + \gamma_2 \mathbf{Y}_{i,t,m} + \delta_{m,t} + \epsilon_{i,t,m}, \quad (2.1)$$

in which the main dependent variable $\text{Risk}_{i,t,m}$ is measured as the average Loan-to-Income Ratio (LIR) of bank i in year t in MSA m. We calculate this ratio per loan application as the loan amount relative to gross annual income of the applicant (both in US$ thousands) and then we average these at the bank-year-MSA-level. It represents the affordability of the mortgage at origination. Assuming that income stays relatively constant over time, it depicts a borrower's ability to comply with monthly repayments. If the loan amount is high relative to annual gross income, repayment might be

[1] MSAs are geographic entities delineated by the Office of Management and Budget. They consist of at least one urban county plus adjacent counties with a high degree of social and economic integration.

TABLE 2.1: Summary statistics.

	Mean	Standard Deviation	Percentile 1st	99th
Dependent Variables				
LIR total	1.859	1.271	0.321	4.069
LIR accepted	1.806	1.292	0.278	3.987
LIR rejected	2.148	3.541	0.271	7.000
Log(Inc)	4.340	0.508	3.390	6.151
Log(Loan)	4.719	0.671	2.965	6.454
Rejection Rate total	0.148	0.206	0.000	0.872
Rejection Rate subprime	0.075	0.388	0.000	0.667
Independent Variables on the Bank-MSA-level				
Non-resale Rate	0.510	0.408	0.000	1.000
Mortgage Market Share	0.007	0.016	0.000	0.078
Log(Demand)	7.971	2.058	3.761	13.112
Independent Variables on the Bank-level				
Market Power (Lerner index)	0.430	0.131	0.159	0.866
ROE	0.120	0.082	-0.094	0.332
Efficiency	0.650	0.206	0.344	1.121
Tier1	0.144	0.075	0.073	0.405
Non-curr. Loans	0.009	0.012	0.000	0.053
Liquidity	0.822	0.094	0.494	0.930
Non-int. Income	0.123	0.091	0.015	0.493
Mortgage Loans	0.120	0.279	0.001	0.891
Log(Assets)	12.421	1.498	10.152	17.641
Interaction Variables				
Entry (3 years)	0.365	0.481	0.000	1.000
Branch Presence	0.297	0.457	0.000	1.000
Log(Distance)	5.540	1.466	2.945	7.823

Notes: Summary statistics include 270,373 observations of 7,612 banks. Summary statistics on *Log(Distance)* include 205,649 observations of 6,414 banks.

harder for the borrower. Therefore, higher LIRs indicate higher risk. LIRs are common measures of borrower risk in the mortgage market used by banks and regulators (Duchin and Sosyura, 2014; Dell'Ariccia et al., 2012) and correlate strongly with credit FICO-scores, which provide more detailed information on the creditworthiness of borrowers (Rosen, 2011).

Since we use loan application data, we focus on risk-taking during the screening process. We do not know how each of these loans performs afterward. However, we control for the main risk management technique used by banks for hedging these credit risks, i.e., we observe which loans are sold within one year after origination to mortgage companies such as Freddie Mac and Fannie Mae. Moreover, with the benefit of hindsight, we know that high LIR-loans were risky since relying solely on Loan-to-Value ratios was proven wrong when the housing market collapsed in 2008. Nevertheless, we are not able to control for Loan-to-Value ratios which is a shortcoming of the HMDA data we use. But Campbell and Cocco (2015) provide a theoretical model showing that LIR affect default decisions through a different channel than Loan-to-Value ratios but can be just as important. Additionally, we use the rejection rate as a measure of lenient lending standards as in Dell'Ariccia et al. (2012), and the rejection rate to the lowest income quartile as a proxy for subprime lending.

Our main independent variable to proxy for market power is the Lerner index. It is calculated as

$$\text{Lerner}_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}}, \tag{2.2}$$

where $P_{i,t}$ is calculated as average revenue, i.e., total income to total assets, and $MC_{i,t}$ is estimated with a translog total cost function as in Koetter et al. (2012b). In a highly competitive environment, banks charge prices close to their marginal costs. Market power is expressed through the Lerner index as the ability to charge a mark-up which creates a positive charter value for the bank. Our hypothesis is that if banks have market power, they are willing to protect positive charter values by taking less risks (Keeley, 1990). In that case, we expect that β would be negative.

We include fixed effects at the bank-level and MSA-year-level. Thereby, we control for time-invariant heterogeneity across banks, like differences between thrifts and commercial banks or general unchanging risk attitudes, and bank-invariant heterogeneity across MSAs in each year, like time-variant regional demand factors. We absorb any variation but time-varying variation between banks who operate within the same MSA in any given year. We compare risk-taking in the mortgage market between banks with different market power. Note the different dimensions between our outcome variable and regressor of interest. Because banks derive their market power not only from mortgage business, we calculate the Lerner index based on the entire loan and security business. This alleviates concerns about potential reverse causality but it necessitates to control for bank specific factors within a MSA which we do by including vector $\mathbf{Y}_{i,t,m}$. Here, we control for the local competitive environment with the mortgage market share and for bank-specific demand with the logarithm of total volume of loan applications to each bank which we both lag by one year. Further we control for the propensity to keep risks of a certain MSA in the balance sheet by including the ratio of not-resold mortgage loans to total loans. For the vector $\mathbf{X}_{i,t}$ we choose other determinants of risk at the bank-level. We account for CAMEL variables and bank business models. We do not have any accounting information on a local level, e.g. for bank branches, to construct similar measures on a regional level. Therefore, one might argue we omit factors on the local level. We show, however, that on average there is only a 29.7% chance that banks operate branches in a MSA where they issue mortgage loans. Furthermore, to account for an unobserved bank-region effect, we cluster standard errors at the bank-MSA-level. Lastly, we control for the attention a bank might pay to its mortgage business by including the share of mortgage business relative to total assets.[2]

2.4 Results

Column (1) of Table 2.2 presents our baseline results. We find that the coefficient for the Lerner Index is negative and significant at the 5% level which indicates that if banks have more market power, their mortgage

[2] We provide summary statistics for all variables in Table 2.1 and detailed definitions in Table 2.9.

TABLE 2.2: Effect of market power on risk-taking.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent	Loan-to-Income Ratio			Log	Log	Rejection Rate	
Variable:	total	accepted	rejected	(Inc)	(Loan)	total	subprime
Market Power	-0.073**	-0.098***	0.000	-0.021*	-0.083***	-0.025***	-0.013
	(0.035)	(0.037)	(0.093)	(0.012)	(0.016)	(0.005)	(0.009)
Non-resale Rate	-0.163***	-0.183***	-0.194***	0.028***	-0.125***	0.024***	-0.022***
	(0.011)	(0.011)	(0.054)	(0.004)	(0.005)	(0.002)	(0.004)
L.Log(Demand)	-0.567***	-0.368**	-0.875**	-0.224***	-0.814***	-0.102***	0.116***
	(0.140)	(0.144)	(0.442)	(0.063)	(0.083)	(0.024)	(0.039)
L.Mortg. Market Share	0.026***	0.022***	0.034***	-0.007***	0.018***	0.005***	-0.002***
	(0.002)	(0.002)	(0.008)	(0.001)	(0.001)	(0.000)	(0.001)
ROE	0.243***	0.246***	0.254**	-0.026**	0.176***	0.025***	0.042***
	(0.039)	(0.041)	(0.129)	(0.013)	(0.017)	(0.006)	(0.008)
Efficiency	-0.005	-0.004	-0.177***	-0.019***	0.004	0.017***	0.005*
	(0.014)	(0.014)	(0.066)	(0.007)	(0.008)	(0.003)	(0.003)
Tier 1	0.044	0.016	-0.053	-0.030*	-0.022	-0.019	0.003
	(0.054)	(0.060)	(0.092)	(0.018)	(0.022)	(0.012)	(0.008)
Non-curr. Loans	-0.012	-0.037	1.642	-0.596***	-0.921***	0.378***	0.034
	(0.375)	(0.393)	(1.068)	(0.120)	(0.148)	(0.048)	(0.118)
Liquidity	0.103***	0.070*	0.300***	0.004	-0.016	-0.011*	-0.024***
	(0.036)	(0.038)	(0.106)	(0.014)	(0.020)	(0.006)	(0.008)
Log(Assets)	0.001	0.012	0.019	-0.004	0.014***	-0.006***	-0.011***
	(0.007)	(0.007)	(0.023)	(0.003)	(0.004)	(0.001)	(0.002)
Non-int. Income	0.019	0.003	0.115	-0.073***	-0.172***	-0.022***	-0.030**
	(0.037)	(0.040)	(0.116)	(0.013)	(0.018)	(0.007)	(0.014)
Mortgage Loans	0.017	0.015	0.104***	0.006***	0.067***	-0.008***	-0.001
	(0.011)	(0.016)	(0.035)	(0.001)	(0.004)	(0.001)	(0.001)
Observations	270,373	270,373	175,697	269,613	270,373	270,373	270,031
Banks	7,612	7,612	6,657	7,607	7,612	7,612	7,609
R-squared	0.170	0.167	0.101	0.561	0.633	0.573	0.100
R-squared (within)	0.0025	0.0024	0.0006	0.0022	0.0151	0.0066	0.0004
Depvar Mean	1.859	1.806	2.147	4.34	4.719	0.148	0.075
Depvar Median	1.829	1.791	1.919	4.281	4.746	0.064	0.017
Depvar SD	1.271	1.292	3.545	0.508	0.671	0.206	0.388
MSA×Year & Bank FE	yes	yes	yes	yes	yes	yes	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Columns (1)-(7) are estimated for 1995-2005 with bank fixed effects and MSA×Year fixed effects. Dependent variables are indicated in the heads of the Columns. Independent variable of interest is *Market Power* which is measured by the Lerner index. Other independent variables are: *Non-resale Rate* is the ratio of accepted and not resold loans to total accepted loans. *L.Log(Demand)* is the logarithm of the total volume of loan applications in the MSA in the previous year. *L.Mortg. Market Share* is a bank's market share of the total volume of applications in the MSA in the previous year. At the bank-level we control for Return-on-Equity (*ROE*), administrative costs to income ratio (*Efficiency*), Tier 1 capital ratio (*Tier 1*), non-current to total loans ratio (*Non-curr. Loans*), deposits to total assets ratio (*Liquidity*), size (*Log(Assets)*), non-interest to total income ratio (*Non-int. Income*), and accepted mortgage loan volume to total assets (*Mortgage Loans*).

customers have lower Loan-to-Income Ratios which is evidence in favor of the charter value hypothesis by Keeley (1990) because banks with more market power reduce their risk-taking and preserve their charter. In economic terms this means that if banks increase their market power by one standard deviation (0.13), Loan-to-Income Ratios go down by 0.01 which means a reduction of 73 basis points in terms of the standard deviation of LIRs.

The control variables that come out significant provide reasonable effects. We find that if the portion of loans that stays on the balance sheet of the banks is higher, LIRs go down as well, which again shows that if banks hold the mortgage risk, they are more careful by choosing their customers and ask for more income for each US$ of mortgage loan that they provide. The results also indicate that if past demand for mortgage loans is higher, LIRs decrease, too, which again indicates that if banks can be more selective in providing loans, they take care of the risk. The estimate for the banks' past loan market share in an MSA is positive and thereby hints, that if banks have more information about the MSA, they can afford to provide larger loans per income. Last, we find that if banks are more profitable and/or are more liquid, they also provide more risky loans.

Columns (2) and (3) of Table 2.2 show that the overall effect stems from accepted loans. Column (4) and (5) further provide evidence that both components of the LIR (income and the amount of the loans, both in natural logarithm) decrease with higher levels of bank market power and thereby show that LIRs decrease by lower loan volumes, not higher required income. Results in Column (6) suggest that this does not imply that banks with higher market power accept overall less loans, since rejection rates are significantly lower. At odds with the findings of Dell'Ariccia et al. (2012), however, we do not see this effect in the subprime segment as we find insignificant results when we use the rejection rates in the subprime mortgage market only.

Our second set of results presented in Table 2.3 sheds light on important factors that influence the impact of banks' market power on LIRs. In the first Column, we investigate banks' market shares in a MSA. According to Marquez (2002), the screening ability of banks is proportional to their market share and therefore should matter for the decision on mortgage provision. We find that if banks hold a larger share of mortgage loans in a market, the effect of banks' market power on LIRs is significantly less negative. As Figure 2.1a in Appendix A shows, the marginal effect of banks' market power does not become positive, only insignificant. Therefore, we cannot support the predictions of Marquez (2002). In the same vein, Column (2) shows that banks that entered a MSA only three years ago provide loans with a significantly higher LIR if they have more market power then incumbent banks that already have a longer presence in the same market. This might indicate that new banks in a market have fewer information (Acharya et al., 2006), which might leave them with riskier customers. Another explanation is that entrants use teaser loans to attract customers for the first time. Our results are in line with Dell'Ariccia (2001) who shows that lock-in of private information by incumbent banks can deter new entrants into an industry or market. Overall, the total marginal effect of banks' market power on LIRs is insignificant for the group of relatively new incumbents. The third Column shows that the effect of banks' market power is aggravated if banks have a branch in the MSA where they offer mortgage loans. This might indicate that banks that have a branch installed care more about the risk of the loans since they want to secure their charter and their presence in the region or that they are better able to assess the risk because they can accumulate more accurate information about the market through a branch, e.g. by hiring local staff. The last Column investigates the role of distance (Petersen and Rajan, 2002; Degryse and Ongena, 2005; Hauswald and Marquez, 2006) for the importance of information acquisition of banks. We provide evidence that banks with more market power allow for higher LIRs when the distance between the MSA and the banks' headquarters is larger. Again, this potentially shows that if the customer is more distant, banks have fewer information and are left with the riskier customers, or higher LIRs might be seen as an indication that banks try to enter a distant market with more favorable loans to the customers. As Figure 2.1b in Appendix A shows, the effect of banks' market power on LIRs only turns positive for very distant MSAs but never becomes positive and significant. All in all, these results demonstrate that banks utilize information for the means of preserving their charter value. In the light

TABLE 2.3: Aggravating effect of information on the risk-mitigating effect of market power.

Dependent Variable: LIR total *Interaction Variable:*	(1) Mortgage Market Share	(2) Entry (3 years)	(3) Branch Presence	(4) Log (Distance)
Market Power	-0.080**	-0.082**	-0.047	-0.379***
	(0.036)	(0.035)	(0.037)	(0.087)
Interaction	-0.657**	-0.002	0.016	-0.006
	(0.286)	(0.013)	(0.020)	(0.010)
Market Power×*Interaction*	1.513***	0.054***	-0.104***	0.050***
	(0.442)	(0.020)	(0.027)	(0.013)
Observations	270,373	270,373	270,373	205,649
Banks	7,612	7,612	7,612	6,414
R-squared	0.170	0.170	0.170	0.161
R-squared (within)	0.0025	0.0026	0.0027	0.0019
Depvar Mean	1.859	1.859	1.859	1.876
Depvar Median	1.829	1.829	1.829	1.833
Depvar SD	1.271	1.271	1.271	1.365
Bank Controls	yes	yes	yes	yes
Bank×MSA Controls	yes	yes	yes	yes
MSA×Year & Bank FE	yes	yes	yes	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Columns (1)-(4) are estimated with bank fixed effects and MSA×Year fixed effects for 1995-2005 with *LIR total* as the dependent variable. Interaction variables are indicated in the heads of the Columns. Shown independent variable is *Market Power* which is measured by the Lerner index. Bank×MSA-level control variables are included but not shown and are: *Non-resale Rate*, *L.Log(Demand)*, and *L.Mortgage Market Share* (which is additionally interacted with *Market Power* in Column (1). Bank-level control variables are included but not shown and are Return-on-Equity (*ROE*), administrative costs to income ratio (*Efficiency*), Tier 1 capital ratio (*Tier 1*), non-current to total loans ratio (*Non-current Loans*), deposits to total assets ratio (*Liquidity*), size (*Log(Assets)*), non-interest to total income ratio (*Non-Interest Income*), and accepted mortgage loan volume to total assets (*Mortgage Loans*).

of Boot and Thakor (2000) we provide evidence that relationship banking adds to banks' charter values.

2.5 Robustness and further results

The following section provides details on our main result as well as robustness checks. In Table 2.4 we report results for the first six and last five years of our sample period separately. According to Keys et al. (2012), the increasing availability and use of securitization of credit risk in the mortgage market weakened screening incentives significantly since 2001. In order to test whether our results hold for this period or are driven mainly by the late 1990s, we split the sample in 2001 and estimate our baseline regression as in Table 2.2. While in Column (1) the effect of market power on the total Loan-to-Income Ratio turns insignificant in the years 2001-2005, we see in Column (2) that banks with more market power still accept on average customers with lower LIRs. Indeed, contrary to the results of the full sample and the years 1995-2000, we find that the coefficients for the Lerner index are positive and significant at the 1% level in the regressions on the average LIR of rejected loan applications in Column (3) and the mean income of accepted loan applicants in Column (4). This affirms that banks with higher charter value increasingly relied on information about income to issue safer loans. Column (6) shows that the negative coefficient for the effect of market power on the rejection rate in Column (6) in Table 2.2 stems from the period 2001-2005 and that banks with more market power had significantly higher rejection rates in the period 1995-2000.

One concern is our choice of using the Lerner index as a measure of market power. Many studies use the Herfindahl-Hirschman Index (HHI) which is the sum of squared market shares of all banks in a certain market. As such it proxies whether market power in terms of market shares is concentrated on few or dispersed across many banks. The latter situation is considered a more competitive environment. In Table 2.5 we estimate our effect of market power on total LIR using HHI as a proxy. In Column (1) we see that the relationship between market power and risk-taking is reversed yielding a positive coefficient significant at the 5% level. As pointed out by Carbo-Valverde et al. (2009), Lerner index and HHI often yield competing results. They show that results can be reconciled by controlling for demand elasticity and variations in market contestability as well as relationship banking. Following this advise, we include *Log(Distance)* as a measure for the intensity of relationship banking in Column (2), *Number of Entrants* as a measure of market contestability in Column (3), both in Column (4), and interact them with market power. We find that the coefficient on market power measured by HHI changes the sign once we control for contestability of the market and/or relationship banking which results in similar results to our baseline.

In order to mute concerns regarding incorrect measurement of competition due to Bank Holding Company (BHC) structures, we estimate our baseline in Table 2.6 in Columns (1) and (2) only for independent depository institutions that are not part of a BHC and add a control dummy variable in Columns (3) and (4) as in Loutskina and Strahan (2011) which indicates whether a bank is part of a holding. The idea is that banks that belong to the same BHC do not compete with each other. Therefore, their market power should be assessed on the level of the BHC. In our analysis, we refrain from aggregating at the BHC since the decisions of risk-taking, especially loan officers' decisions about loan applications, are taken on the individual bank-level. We find that the effect of market power on LIR of accepted loan applications is robust to these procedures, while the effect on LIR of all applications stays negative but is not significant when the dummy *BHC subsidiary* is introduced. The dummy is positive and significant, indicating that banks belonging to a BHC have higher average LIRs.

Finally, we show in Column (1) of Table 2.7 that our results are not driven by outliers. Here we winsorized all variables at the 1st and 99th percentile. In Columns (2) and (3) we find that our results are robust to clustering standard errors at the MSA-level but not to clustering at the bank-level. Comparing to the baseline in Column (6) of Table 2.8, we see that standard errors clustered at the MSA-level are almost identical to standard errors clustered at the bank-MSA-level. This suggests that residuals are clustered at the MSA-level, which is the more refined level of our panel, and the bank effect (correlation of residuals across time within a bank) is not that important once we control for within MSA variation (Petersen, 2009) and once we include bank-level fixed effects (note that standard errors as well as R^2 increase when these fixed effects are present as in Columns (4)-(6) of

Table 2.8). Consequently, standard errors clustered *only* at the bank-level may be biased.

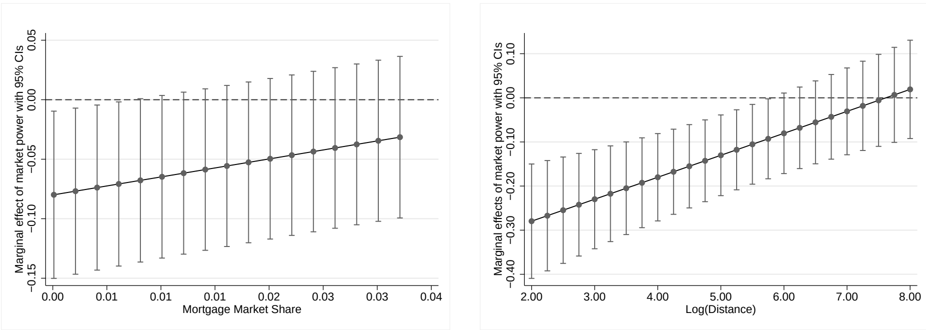
2.6 Conclusion

This paper sheds light on the role of bank market power for the provision of mortgage loans before 2007. We find that banks with more market power significantly reduce Loan-to-Income Ratios which is an indication for saver business. We also show that traditional relationship banking proxies, like distance to a market and time of presence in the market, play a significant role for the transmission of banks' market power on their mortgage market business. Overall, we find that banks closer to their customer or those with a branch presence significantly reduce LIRs even further with higher market power. Thereby, our paper adds to the findings by Keeley (1990) or Jiménez et al. (2013) who advocate the charter value paradigm in banking.

Appendix A

FIGURE 2.1: Marginal effect of market power on risk-taking over the distribution of market shares and distance.

(A) Mortgage Market Share (B) Distance



Notes: This Figure shows the marginal effect of market power on the Loan-to-Income Ratio conditional on mortgage market shares and distances in logs between headquarters and markets. The dots represents the marginal effects and the solid line the 95% confidence interval.

TABLE 2.4: The effect of market power on risk-taking in the years 1995 to 2000 and 2001 to 2005.

Dependent Variable:	(1) total	(2) accepted	(3) rejected	(4) Log (Inc)	(5) Log (Loan)	(6) total	(7) subprime
	Loan-to-Income Ratio					Rejection Rate	
1995-2000							
Market Power	-0.104***	-0.104***	-0.406*	-0.042**	-0.062***	0.020**	-0.000
	(0.040)	(0.040)	(0.217)	(0.017)	(0.022)	(0.008)	(0.003)
Observations	123,409	123,409	79,787	123,409	123,409	123,409	123,409
Banks	5,953	5,953	5,086	5,953	5,953	5,953	5,953
R-squared	0.181	0.191	0.080	0.571	0.629	0.610	0.575
R-squared (within)	0.002	0.0019	0.0003	0.0039	0.0057	0.0077	0.0041
Depvar Mean	1.747	1.692	2.022	4.233	4.564	0.154	0.047
Depvar Median	1.747	1.711	1.833	4.176	4.616	0.067	0.011
Depvar SD	1.09	1.055	4.328	0.485	0.624	0.215	0.082
Bank & MSA×Bank Controls	yes	yes	yes	yes	yes	yes	yes
MSA×Year & Bank FE	yes	yes	yes	yes	yes	yes	yes
2001-2005							
Market Power	-0.080	-0.183***	0.413***	0.073***	-0.007	-0.060***	0.002
	(0.051)	(0.056)	(0.149)	(0.019)	(0.024)	(0.009)	(0.014)
Observations	146,628	146,628	95,338	145,866	146,628	146,628	146,286
Banks	5,106	5,106	4,392	5,099	5,106	5,106	5,103
R-squared	0.184	0.174	0.205	0.553	0.645	0.579	0.116
R-squared (within)	0.0034	0.003	0.0028	0.0018	0.0261	0.0075	0.0012
Depvar Mean	1.953	1.902	2.252	4.431	4.849	0.142	0.098
Depvar Median	1.912	1.874	2	4.365	4.862	0.063	0.022
Depvar SD	1.399	1.455	2.723	0.509	0.682	0.198	0.52
Bank & MSA×Bank Controls	yes	yes	yes	yes	yes	yes	yes
MSA×Year & Bank FE	yes	yes	yes	yes	yes	yes	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All regressions include *Non-resale Rate*, *L.Log(Demand)*, *L.Mortg. Market Share*, *ROE*, *Efficiency*, *Tier 1*, *Non-curr. Loans*, *Liquidity*, *Log(Assets)*, *Non-int. Income*, and *Mortgage Loans* as control variables as well as bank fixed effects and MSA×Year fixed effects. *Market Power* is measured using the Lerner index in all regressions.

TABLE 2.5: Robustness against using the Herfindahl-Hirschman Index as a concentration based measure of market power.

Dependent Variable: LIR total *Interaction channel*	(1) *(none)*	(2) Information	(3) Contestability	(4) Info. & Contest.
Market Power	0.370**	-0.537	-0.643**	-1.569*
	(0.179)	(0.814)	(0.317)	(0.855)
Distance		0.021***		0.021***
		(0.007)		(0.007)
Market Power×Distance		0.192		0.189
		(0.139)		(0.139)
Number of Entrants			0.001***	0.001***
			(0.000)	(0.000)
Market Power×Number of Entrants			0.011***	0.011**
			(0.003)	(0.004)
Log(Income)	0.123*	0.072	-0.070	-0.114
	(0.070)	(0.087)	(0.072)	(0.089)
Employmentrate	0.825***	0.747**	0.654***	0.582**
	(0.237)	(0.293)	(0.237)	(0.294)
Log(Per-capita Income)	0.141	0.208	0.313**	0.374**
	(0.122)	(0.155)	(0.123)	(0.156)
Observations	270,373	205,658	270,373	205,658
R-squared	0.158	0.146	0.158	0.146
R-squared (within)	0.0028	0.0021	0.003	0.0023
Depvar Mean	1.859	1.876	1.859	1.876
Depvar Median	1.829	1.833	1.829	1.833
Depvar SD	1.271	1.365	1.271	1.365
Bank, & MSA×Bank Controls	yes	yes	yes	yes
Bank, MSA, & Year FE	yes	yes	yes	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All regressions include *Non-resale Rate, L.Log(Demand), L.Mortg. Market Share, ROE, Efficiency, Tier 1, Non-curr. Loans, Liquidity, Log(Assets), Non-int. Income*, and *Mortgage Loans* as control variables as well as Bank fixed effects, MSA fixed effects, and Year fixed effects. *Market Power* is measured by the HHI calculated at the MSA-level based on *Mortgage Market Share*. Since the HHI varies by MSA and year, we cannot include MSA×Year fixed effects as in our baseline. Therefore, we add *Log(Income), Employmentrate*, and *Log(Per-capita Income)* as control variables to account for common economic factors at the MSA-level which could determine credit demand and creditors' risk. The sample period is 1995-2005.

TABLE 2.6: Robustness regarding Bank Holding Companies.

	(1)	(2)	(3)	(4)
	excl. BHC		control BHC	
Dependent Variable:	LIR total	LIR accepted	LIR total	LIR accepted
Market Power	-0.093**	-0.100**	-0.056	-0.086**
	(0.048)	(0.050)	(0.036)	(0.039)
BHC subsidiary			0.174***	0.127**
			(0.043)	(0.052)
Observations	185,034	185,034	270,373	270,373
Banks	7,042	7,042	7,612	7,612
R-squared	0.161	0.160	0.170	0.167
R-squared (within)	0.003	0.0031	0.0026	0.0024
Depvar Mean	1.811	1.756	1.859	1.806
Depvar Median	1.758	1.718	1.829	1.791
Depvar SD	1.445	1.439	1.271	1.292
MSA×Year & Bank FE	yes	yes	yes	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. In Columns (1) and (2) reporting institutions which have another reporting institution filed as their parent are excluded, this way only independently competing banks remain in the sample. In Columns (3) and (4) the dummy variable *BHC subsidiary* is included indicating whether an reporting institution files another institution as its parent. All regressions include *Non-resale Rate, L.Log(Demand), L.Mortg. Market Share, ROE, Efficiency, Tier 1, Non-curr. Loans, Liquidity, Log(Assets), Non-int. Income*, and *Mortgage Loans* as control variables as well as Bank fixed effects and MSA×Year fixed effects. *Market Power* is measured by the Lerner index. The sample period is 1995-2005.

TABLE 2.7: Robustness regarding clustering and winsorizing.

Dependent Variable: LIR total	(1)	(2)	(3)
	Winsorizing	Clustering	
		MSA-level	Bank-level
Market Power	-0.045**	-0.073**	-0.073
	(0.019)	(0.036)	(0.101)
Observations	270,373	270,373	270,373
Banks	7,612	7,612	7,612
R-squared	0.414	0.170	0.170
R-squared (within)	0.0149	0.0025	0.0025
Depvar Mean	1.837	1.859	1.859
Depvar Median	1.829	1.829	1.829
Depvar SD	0.709	1.271	1.271
Bank & MSA×Bank Controls	yes	yes	yes
MSA×Year & Bank FE	yes	yes	yes

Notes: Clustered standard errors in Column (1) at the Bank-MSA-level, in Column (2) at the MSA-level, and in Column (3) at the Bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. In Column (1) the dependent variable *LIR (total)* is winsorized at the 1st and 99th percentile. In Column (2) and (3) the dependent variable is (not winsorized) *LIR (total)*. All regressions include *Non-resale Rate, L.Log(Demand), L.Mortgage Market Share, ROE, Efficiency, Tier 1, Non-current Loans, Liquidity, Log(Assets), Non-interest Income*, and *Mortgage Loans* as control variables as well as Bank fixed effects and MSA×Year fixed effects. *Market Power* is measured by the Lerner index. The sample period is 1995-2005.

Table 2.8: Narrowing down the effect of market power with different fixed effect specifications.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	LIR total					
Market Power	-0.048***	-0.043***	-0.014	-0.057	-0.058*	-0.073**
	(0.015)	(0.015)	(0.014)	(0.035)	(0.035)	(0.035)
Non-resale Rate	-0.306***	-0.301***	-0.301***	-0.133***	-0.158***	-0.163***
	(0.008)	(0.008)	(0.007)	(0.011)	(0.011)	(0.011)
L.Log(Demand)	-1.837***	-1.975***	-0.918***	-1.250***	-0.579***	-0.567***
	(0.138)	(0.143)	(0.120)	(0.148)	(0.134)	(0.140)
L.Mort. Market Share	0.053***	0.054***	0.040***	0.042***	0.028***	0.026***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log(Income)	-0.001	0.001	0.013	0.001	0.137**	
	(0.003)	(0.004)	(0.072)	(0.004)	(0.069)	
Employmentrate	-0.461***	-0.364***	0.772***	-0.067	0.818***	
	(0.043)	(0.045)	(0.240)	(0.049)	(0.237)	
Log(Per-capita Inc.)	0.718***	0.659***	0.300**	0.446***	0.134	
	(0.019)	(0.026)	(0.122)	(0.029)	(0.121)	
ROE	-0.296***	-0.292***	-0.267***	0.237***	0.240***	0.243***
	(0.052)	(0.053)	(0.052)	(0.039)	(0.039)	(0.039)
Efficiency	-0.036***	-0.048***	-0.045***	-0.001	-0.003	-0.005
	(0.011)	(0.011)	(0.011)	(0.014)	(0.014)	(0.014)
Tier 1	0.021	-0.015	0.016	0.004	0.014	0.044
	(0.044)	(0.045)	(0.043)	(0.053)	(0.052)	(0.054)
Non-curr. Loans	0.434	0.665**	0.889***	-0.270	-0.198	-0.012
	(0.333)	(0.333)	(0.328)	(0.377)	(0.376)	(0.375)
Liquidity	0.113***	0.093***	0.112***	0.086**	0.081**	0.103***
	(0.020)	(0.020)	(0.020)	(0.036)	(0.036)	(0.036)
Log(Assets)	0.016***	0.017***	0.010***	-0.002	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.007)
Non-Int. Income	-0.300***	-0.363***	-0.362***	0.004	-0.006	0.019
	(0.023)	(0.024)	(0.023)	(0.038)	(0.037)	(0.037)
Mortgage Loans	0.038***	0.038***	0.028***	0.020*	0.019*	0.017
	(0.006)	(0.006)	(0.006)	(0.011)	(0.011)	(0.011)
Observations	270,373	270,373	270,373	270,373	270,373	270,373
R-squared	0.037	0.040	0.066	0.141	0.158	0.170
Year FE	no	yes	yes	yes	yes	no
MSA FE	no	no	yes	no	yes	no
Bank FE	no	no	no	yes	yes	yes
MSA×Year FE	no	no	no	no	no	yes

Notes: Clustered standard errors at the Bank-MSA-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Column (1) shows the OLS-estimate of *Market Power* with control variables at the bank-level, MSA-level, and bank-MSA-level. In Column (2) time-invariant variation across banks and markets is absorbed by including time fixed effects. In Column (3) we add MSA fixed effects. In Column (4) we regress with bank fixed effects and year fixed effects. In Column (5) we have bank fixed effects, MSA fixed effects, and time fixed effects. Column (6) shows our baseline result including bank fixed effects and MSA×Year fixed effects. Columns (1)-(6) include *Non-resale Rate, L.Log(Demand), L.Mortgage Market Share, ROE, Efficiency, Tier 1, Non-current Loans, Liquidity, Log(Assets), Non-interest Income*, and *Mortgage Loans* as control variables. Additionally, Columns (1)-(5) include *Log(Income), Employmentrate*, and *Log(Per-capita Income)*. The sample period is 1995-2005.

Table 2.9: Variable definitions.

Variable	Definition	Unit
Dependent Variables on the Bank-MSA-level	(*Source*: HMDA.)	
LIR total	Average Loan-to-Income Ratio of all applications.	dec.
LIR accepted	Average Loan-to-Income Ratio of all accepted applications.	dec.
LIR rejected	Average Loan-to-Income Ratio of all rejected applications.	dec.
Log(Inc)	Logarithm of the average income of all received applications.	Log($K)
Log(Loan)	Logarithm of the average loan volume of all received applications.	Log($K)
Rejection Rate total	Number of rejected applications to total number of applications.	dec.
Rejection Rate subprime	Number of rejected applications of applicants with income in the lowest income quartile of the MSA to total number of applications.	dec.
Independent Variables on the Bank-MSA-level	(*Source*: HMDA.)	
Non-resale Rate	Number of accepted applications which are not resold to GSEs within one year to total number of accepted applications.	dec.
Mortg. Market Share	Total loan volume of all applications to a bank relative to total volume of applications to all banks within a MSA.	dec.
Log(Demand)	Logarithm of the total loan volume of all applications to a bank.	dec.
Independent Variables on the Bank-level	(*Source*: SDI.)	
ROE	Net income to average total equity on a consolidated basis.	dec.
Efficiency	Non-interest expense less amortization to total net income.	dec.
Tier1	Tier 1 capital to risk-weighted assets as defined by the appropriate federal regulator at the time.	dec.
Non-curr. Loans	Total noncurrent loans and leases, loans and leases at least 90 days past due and in nonaccrual status to total gross loans and leases.	dec.
Liquidity	Total deposits to total assets.	dec.
Non-int. Income	Non-interest income, incl. fees, service charges, and trading gains (and losses), to total net income.	dec.
Mortgage Loans	Total loan volume of all applications to a bank in all regions winsorized at the 5th and 95th percentiles to total assets.	dec.
Log(Assets)	Logarithm of total assets.	Log($K)
Market Power	Lerner Index defined in Eq. 2.2 where $P_{i,t}$ is average revenue calculated as total net income and $MC_{i,t}$ are marginal costs estimated using a translog total cost function as in Koetter et al. (2012b). It uses labor, capital, and financing costs as inputs and loans to individuals, real-estate loans, commercial loans and securities as outputs, equity, and a time trend factor.	dec.
Interaction Variables on the Bank-MSA-level	(*Sources*: ⋆Census, *HMDA, †SDI, ‡SoD.)	
Entry (3 years)	Dummy indicating new entrants within the first 3 years of receiving loan applications in a MSA.*	$0-1$
Branch Presence	Dummy indicating whether an institution operates at least one branch in the MSA where it receives loan applications.*‡	$0-1$
Log(Distance)	Logarithm of the average distance between the county of banks' headquarters and the counties of principle cities of each MSA. Note that distances above 50,000 miles are not available.⋆*†	Log(miles)
Independent Variables on the MSA-level	(*Source*: BEA.)	
Log(Income)	Logarithm of Personal Income that persons receive in return for their provision of labor, land, and capital, and other income.	Log($K)
Employmentrate	Number of employed full-time-equivalents to total population.	dec.
Log(Per-capita Inc.)	Logarithm of per-capita Income.	Log($K)

Notes: HMDA (Home Mortgage Disclosure Act) data is available on the Federal Financial Institutions Examination Council's (FFIEC) web site. SDI (Statistics of Depository Institutions) and SoD (Summary of Deposits) data is available on the Federal Deposit Insurance Corporations (FDIC) web site. We obtained macroeconomic data on the MSA-level from the U.S. Bureau of Economic Analysis (BEA).

Chapter 3

Profitability sclerosis and political exit barriers in banking [*]

Abstract: *We test if political barriers hamper Schumpeterian destruction in banking by exploiting exogenous shocks to the governance structure of local government-owned banks. We compare the effect of private and government-owned bank exits due to mergers in the wake of reforming political entities, namely counties. Bank exits induced by a reduction of political frictions enhance bank profitability and efficiency, but also lead to riskier financial profiles. Yet, banks lend more at lower cost after forced mergers. Lower financing cost of firms are associated with more investment and employment, suggesting that the removal of political barriers unleashed both banks and firms potential.*

3.1 Introduction

A widely noticed report by the European Systemic Risk Board (ESRB, 2014) voiced strong concerns that Europe is over-banked. Excess capacities would explain why profits remain notoriously low, which in turn might even jeopardize financial stability (ECB, 2016; ECB, 2017; EBA, 2017). So why do we observe so few banks that exit the industry? And is it indeed the absence of such Schumpeterian destruction in banking, which impedes profitability?

This paper tests if political frictions obstruct the industrial dynamics in the banking sector called for by policy makers. Basic finance theory predicts that the threat of outside investors to acquire inefficiently managed assets – financial or non-financial ones – suffices to discipline managers so as to act in the interest of shareholders (Manne, 1965; Jensen and Meckling, 1976). But if these control mechanisms are subject to frictions – say pervasive government ownership – factor allocation is inefficient and too few unproductive firms exit, thereby contributing to excess capacities and sluggish technology adoption (Jensen, 1993; Tinn, 2010; Titman, 2013).

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Especially European banking systems are characterized by equity and other financial markets that play a very limited role to impose managerial discipline (Haan and Vlahu, 2016). Hostile and cross-border takeovers are virtually absent in the European banking industry (DeYoung et al., 2009). And an already fairly weak capital market governance mechanism to force the exit of unproductive entities has been further undermined after the Great Financial Crisis of 2007/2008 and the Sovereign Debt crisis in the Eurozone in 2010. Pervasive nationalization waves (Bosma et al., 2016) paired with increasingly large holdings of sovereign debt by national banking systems (Acharya et al., 2015) increased both the direct as well the indirect reciprocal dependence between governments and "their" banking systems. Therefore, we conjecture that a more pronounced involvement of the government in banking causally deters bank exits, thereby giving rise to ineffective market structures that are associated with weak profitability.

The main challenge to identify whether government involvement poses an impediment to inefficient bank attrition is the innate unobservability of non-occurring exits: by definition, a non-event. We therefore use a novel strategy to isolate a causal mechanism how political frictions impede industrial dynamics. Specifically, our approach exploits that savings banks are forced to merge if their county of residence is merged with another one during an according regional reform. We test if those bank exits that occur once the shelter from consolidation pressure in the form of government ownership disappears, exhibit significantly different post-merger performance. Significantly improved performance would indicate a more efficient allocation of resources by the bank compared to the situation prior to county reforms when the regional market was protected. Thus, we contrast sharply with the abundant literature on the role of political ties to receive government support of some kind that might impede creative destruction (Brown and Dinç, 2005; Duchin and Sosyura, 2012; Dam and Koetter, 2012; Behn et al., 2015). Our identification strategy relies instead on exogenous shifts in the government ownership of some local banks during non-crisis times that reveal the conventionally missing counterfactual of banks leaving the market.

Ownership shifts emerge in our quasi-experimental setting from the fact that local savings banks are the property of the regional government where they reside, usually one of the 402 counties (*Kreise*) nested in the 16 federal states of the Republic of Germany. Savings bank laws (*Sparkassengesetze*) are issued by the state and stipulate besides county ownership that local savings banks are *de jure* not allowed to operate outside "their" regional market. During our sample period from 1993 until 2015, the number of counties declined drastically from 542 to 402. Importantly, these county mergers are decided upon at the level of the *state* – usually for administrative efficiency reasons – and represent as such an exogenous ownership shock to the *counties* that own the savings banks.[1] The latter are required by law to merge after the unification of counties. Put differently, these mergers are forced upon the involved savings bank very much like raider investors take control of inefficiently managed assets in a frictionless market for corporate control.

Our focus is thus on mergers as the exit event of interest, thereby also accounting for the fact that banks rarely exit markets due to outright

[1] Note that county consolidation does not reflect a gerrymandering process ignited by governing parties to maximize their odds of re-election.

insolvencies or voluntary closure during recessions or sector-specific shocks as is common for non-financial sectors.[2] To answer the question whether government involvement in banking is a significant roadblock to sustainable profits in banking, we then use a difference-in-difference model that explains post-merger bank performance according to three main comparisons. First, we only consider reformed counties within which we compare savings to cooperative banks that are not subject to government involvement.[3] Second, we compare merging local savings with merging cooperative banks in both reformed and unreformed counties. Third, we compare merging banks to non-merging banks across reformed and unreformed counties.

We estimate an economically and statistically large increase in the post-merger profitability of government-owned savings banks, if the merger was induced by a reform of the counties where these banks were residing. Depending on the reference group – private bank mergers in reform counties, any merging bank, or all non-merging banks – we find an increase in the return on gross equity (RoE) ranging between 3.8 and 5.7 percentage points. Against the backdrop of mean RoE on the order of 8% in our sample, this effect is economically large.

The decomposition of this profitability development reveals that the RoE improvements are mainly driven by a decline in capitalization. Also credit risk increases as reflected by slightly larger non-performing loan ratios and lower loan-loss provisioning. Profits improve as well, mostly due to larger interest revenues that reflect larger realized markups of the merged entity in its local market. We do not detect, in turn, huge cost efficiency gains. Whereas the number of full-time equivalents (FTE) per branch declines after county-reform induced savings bank mergers, the differential effects on both the absolute number of FTE as well as the wage bill are positive. Hence, we find no empirical indications that banks forced to merge realize efficiency potential by large-scale layoff waves. The headline result is robust to alternative evaluation windows around mergers, robust estimation methods accounting for potential serial correlation of performance, randomized treatment of mergers with placebo county reforms, and explicitly accounting for distressed mergers and observable differences in the strengths of political ties.

To shed light on the real economy implications of eliminating political barriers to banking consolidation, we first assess corporate and consumer lending volumes by local savings banks after reform-induced mergers. We document significant lending increases in these categories. Thus, at least in the German banking system the elimination of regional lenders did not constrain credit access. Related, we do not find a reduction in deposits, a crude measure of retail customer access to financial services. Another potential social cost inflicted by reform-induced mergers could be that

[2]Caballero and Hammour (1994) and Caballero and Hammour (1996) provide theoretical evidence on the importance of firm exits to foster the re-allocation of production factors in particular during recessions when switching cost in the labor market are lower. A number of empirical firm- and plant-level studies show indeed that besides spurring investment, especially the exit of unproductive units is crucial for aggregate output and productivity growth, see for example Baden-Fuller (1989) on the UK Steel Casting industry, Petrin and Levinsohn (2012) for plant data of Chilean manufacturers, or Foster et al. (2006) for the U.S. retail sector.

[3]These Volks- and Raiffeisenbanks are comparable in size to local savings banks and adhere as well to self-imposed regional market demarcation.

post-merger banks return political favors by increasing (local) government lending. We find no support for this kind of undesirable credit allocation. To shed more direct light on the real implications, we then use detailed information about a sample of corporate clients of savings banks. We demonstrate that corporations that are connected to savings banks that were forced to merge after county reforms incur lower external financing cost. Connected corporates also increase investment and employment after forced bank mergers. In sum, our results indicate direct positive bank profitability effects after reducing political roadblocks to market exit, but also important indirect gains realized by the associated corporate sector due to county reforms.

Our paper connects several strands in the literature. First, we complement studies investigating the performance implications of government ownership in banking. Many studies that are based on pre-crisis data report undesirable effects, such as preferred bailout treatment (Behn et al., 2015), political lending (Sapienza, 2004; Halling et al., 2016), especially around elections (Gropp and Saadi, 2015; Englmaier and Stowasser, 2017), and ultimately a poor fulfillment of banks' roles as delegated monitors of corporate lending and guardians of managerial discipline (Berger et al., 2005a; Ivashina et al., 2009) that deters economic growth (La Porta et al., 2002). In response to the Great Financial Crisis, governments around the globe systematically prevented bank exits by injecting equity (Duchin and Sosyura, 2012), which gives rise to a plethora of subsequent effects that further impede "natural" forces of competition to guide entry and exit into the industry.[4] But whereas large and quick U.S. support of banks was followed by an equally rapid retreat of the government from its banking system (Hoshi and Kashyap, 2010; Calomiris and Khan, 2015), the German system remains characterized by a continuously large share of government ownership in banking. Rather than focusing on the effect of government interventions and ownership on bank performance as such, our paper is the first to test directly if unleashing potential impediments to consolidation due to government ownership induced exits through mergers that subsequently enhanced bank performance.

Second, our study speaks to literature on the corporate governance of banks in general and the role of mergers and acquisition (M&A) in particular. An important insight from the deregulation wave in the United States was that the elimination of market barriers enhanced technology adoption and competitive pressure in the banking industry, which in turn increased idiosyncratic bank efficiency and shaped market structure towards a more concentrated and profitable banking system (Berger and Mester, 2003; Stiroh and Strahan, 2003). Yet strengthened shareholder rights due to more transparent, deregulated, and competitive markets for corporate control are no panacea to better governance and subsequent bank performance. Beltratti and Stulz (2012) document for a cross-country sample that those banks managed by boards that are more shareholder-friendly exhibited in fact worse performance during and after the Great Financial Crisis of 2007/2008. And Morck et al. (2011) report for Korean banks that it might not be

[4]See, for example, Gropp et al. (2011) and Berger and Roman (2015) on developments of competition due to bank bailouts in Europe and the United States, respectively, and Duchin and Sosyura (2014) and Dam and Koetter (2012) on additional risk taking due to the moral hazard exerted by government bailouts of banks.

government-ownership per se that leads to poor bank governance – and consequently performance – but other concentrated control rights, such as family or tycoon influence. Prior studies on German bank mergers yield fairly mixed results regarding post-merger performance developments, often failing to report efficiency or profitability gains (Lang and Welzel, 1999; Koetter, 2008; Behr and Heid, 2011). These studies, however, fail to identify causal reasons why banks merged to begin with. If past bank performance co-determined a merger in the first place, any post-merger comparison of performance is subject to a selection bias and possibly reverse causality. Our paper sharpens insights into the bank governance literature because we exploit a clearly exogenous rupture of (government) ownership structures that shield management from a free market for corporate control. Thereby, we are able to isolate performance difference to an otherwise identical set of merging banks.

Third, most prior studies of the governance effects of M&A's are confined by definition to transactions in free markets for corporate control, where more efficiently managed banks identify weak competitors as targets (Hannan and Rhoades, 1987; Wheelock and Wilson, 2000). In the presence of agency-problems, bank managers might be inclined to engage in mergers even though they are not value enhancing, for example, if CEO compensation depends on bank size (Bliss and Rosen, 2001) or CEOs overestimate their ability to manage the merged bank (Roll, 1986). Our study of regional banks run by managers that are prohibited (and protected) by law to merge at will thereby helps to exclude a plethora of potentially rivaling merger motives in free capital markets as possibly confounding explanations of post-merger performance differences. Prior empirical evidence on the efficiency of savings banks by Altunbas et al. (2001) and Micco et al. (2007) do not find significant efficiency differences between government and other banks in Germany. And, in fact, government-owned banks might fulfill important functions that private banks fail to provide. Berger et al. (2005b) provide evidence that monitoring techniques of small banks are better suited for lending to opaque small and medium-sized enterprises (SMEs). Related, Hakenes et al. (2014) show theoretically that small regional banks foster local economic growth and confirm this prediction empirically for German savings banks. Likewise, Berger et al. (2017) demonstrate that small banks possess a comparative advantage to provide liquidity insurance to SMEs, thereby helping to alleviate financing constraints especially of those firms that depend conventionally the most on bank credit. Importantly, Degryse et al. (2011) show that small bank mergers have in particular for those SMEs with just one single relationship the worst implications. Their banking contact is usually dropped and not replaced if their relationship lender turns out to be the target in a bank M&A, a result similar to the one documented before in the United States (Berger et al., 1998). Thus, it is a priori unclear whether forced savings bank mergers induced by county reforms only unlock previously unrealized profitability potential or whether they generate worse conditions for an important group of these banks' customers.

Our paper contributes to the scant evidence on the causal role of alternative mechanisms to impose managerial discipline and exert corporate control if no free market to transfer ownership rights exists. As such, we also shed light on the political economy of government involvement and adjustment dynamics of industrial structures in the financial sector, which also affects the market structure of non-financial industries (Bertrand et al., 2007; Cetorelli and Strahan, 2006; Morck et al., 2011). Especially against the backdrop of the ESRB's claim of prevailing excess capacities, a firmer understanding regarding the drivers of – and impediments to – efficient attrition in this sector of the financial industry aids a better management and policy process to face the ongoing challenges to change banks' business models significantly.

3.2 Institutional background and identification

3.2.1 Local savings banks

In 2015, the German government-owned banking sector comprised 413 regional savings banks that managed an aggregate balance sheet of EUR 2,119 billion assets, a 24% share of the German banking market. The average savings bank has a balance sheet of EUR 2.7 billion and serves a regional market about the size of one county. Jointly they cater to every region in Germany, operate an extensive network of branches, and are owned by regional municipalities or counties.[5]

In addition to national regulation governing all credit institutions, they are subject to federal law regulating ownership, governance structure, and their business model.[6] These laws impose institutional frictions on competition and consolidation in the government-owned banking sector. The geographical scope of business is confined to the territory of the owning locality, also known as regional demarcation (*Regionalprinzip*), *de facto* eliminating competition with other savings banks in credit and deposit markets. Likewise, a free market for corporate control does not exist. Mergers are only permitted between neighboring banks and only within the government-owned banking sector. Decisions about closure and mergers are neither taken by the management nor the supervisory board but by the local governing politicians of the owning county or municipality, to whom we refer henceforth as local politicians. Decisions are subject to approval by the savings bank association and the federal regulator, which is one of the federal ministries. The savings bank association sometimes recommends mergers between distressed and healthy banks as a measure of last resort in order to avoid closure (Koetter et al., 2007; Behn et al., 2015).

The important aspect of regulation with regard to our identification is that counties and municipalities must not own more than one savings bank after county reforms. Federal laws or the reform bills themselves state that in case any of the newly formed counties owns more than one savings bank after a spatial reform, these banks have to merge.[7] Often the reform bills contain a deadline of two or three years within which this consolidation process has

[5]The legal concept of government ownership (*Trägerschaft*) shares key features of private ownership but is not identical. The relevant differences are discussed in the text. In the following, we continue to call local politicians who represent the relevant region over the election cycle the owner of the savings bank.

[6]We distinguish between the local, federal, and national level. The federal level refers to the 16 German states.

[7]See Mecklenburg-Vorpommern: §28 Abs.1a SpkG of Mecklenburg-Vorpommern, §25 LNOG from Juli 1, 1993, and §41 LNOG from Juli 12, 2010; Saxony-Anhalt: §30 Gesetz zur Kreisgebietsreform from July 20, 1993, and §18 LKGebNRG from November 11, 2005; Saxony: §22 SächsKrGebRefG from June 24, 1993, and §25 SächsKrGebNG January 29,

to be completed (see Table 3.11 in the Appendix). Importantly, it is federal and not local politicians who vote on county reforms. The reform-induced mergers are therefore forced on local governments and their government-owned savings banks.

Besides the decision about mergers and closures, local politicians exercise control over savings banks via the supervisory board. The composition of the supervisory board is regulated in detail. The chairman has to be the elected governor of the municipality or county. The remaining board seats are distributed among other local politicians, other bureaucrats, and representatives of employees. Recent studies show that the degree of influence by local politicians is sufficient to distort lending behavior, influence merger patterns, affect choices to lay-off employees, as well as whether and whom to bail out around elections (Hackethal et al., 2012; Behn et al., 2015; Englmaier and Stowasser, 2017). The timing of these phenomena around elections stresses that local politicians that control savings banks pursue vested interests. These interests could also pertain to social and welfare benefits due to owning and managing a bank on behalf and in the interest of the county or municipality itself. By constitution, savings banks serve the public by providing banking services to all regions and promoting the regional economy. Often they engage in charity and foster cultural and sports events.

At the same time, the institutional setting allows the extraction of pecuniary rents on behalf of the county. Since 2002, counties and municipalities, as owners, do not participate in the losses of the bank anymore by issuing guarantees or bailout because the EU commission ruled it to be a distortion of competition. Yet, they are allowed to participate in the profits, which at times gives rise to conflicts between savings bank managers and politicians.[8] The federal laws prescribe a maximum share of distributable profits. The management board proposes the allocation of earnings to the supervisory board which has to affirm it. If the supervisory board is split between representatives of more than one county after a merger, extracting rents for one group of owners becomes increasingly difficult. In conclusion, the institutional background sets incentives for local politicians to prevent mergers in their own private as well as genuine public interest.

3.2.2 German county reforms

Spatial reforms change how the national territory is divided among federal and local political entities. In Germany they occur only on the local level within federal states. The local governmental layer is divided into counties and municipalities. In 2015, there existed 11,168 municipalities that formed 402 counties instead of 543 counties that existed after reunification in 1990 (Statistisches Bundesamt, 2015). We focus on county-level reforms.

County reforms are initiated and decided on by the federal states' parliaments and not by local politicians on the county-level. They are usually linked to functional reforms of the state's administration and accompanied by municipal-level spatial reforms. The main motives are to increase the

2008; Thuringia: §11 ThüMaßnG; Brandenburg §35 BbgSpkG, and §26 KNGBbg December 24, 1992.

[8] Anecdotal evidence shows that only few savings banks distribute profits to their owners (Correctiv Recherchen für die Gesellschaft gemeinnützige GmbH, 2015).

efficiency of administration and to ease fiscal budgets by forming fewer and consequently larger counties (BBSR, 2010).

Since German reunification, eight major reforms took place in five Eastern-German states, each of which reducing the number of counties on average by half. Appendix Table 3.11 shows the number of counties, savings, and cooperative banks before and after each reform. In West-Germany, two metropolitan areas were created: Aachen in North Rhine-Westphalia and Hanover in Lower Saxony. Both county-level reforms implied that two cities were combined with their surrounding counties. These 10 county reforms serve to identify treated savings banks.

Local politicians usually oppose reform plans since they lose their autonomy. Therefore, reforms are heatedly discussed before their legislative passage as well as after. Reform bills are issued by a majority vote of federal politicians. In light of our identification strategy, it is noteworthy that the allocation mechanism of seats in state parliaments implies that a dominant role of federal politicians with the same local interests as local politicians is extremely unlikely. Only around half of the seats of the state parliaments are allocated to politicians who directly represent voting districts. These voting districts are not equal to counties. They are set in such a way so as to represent a certain population (about 60,000 voters). Therefore, less populated rural counties are combined to voting districts and large cities are divided into several voting districts. Since large cities usually keep their status even after county reforms, treated rural counties are underrepresented in state parliaments. The other half of the seats are allocated to politicians that are chosen from a ranked list compiled by each political party. These members of state parliaments therefore do not have to represent any particular local interest per se. They are often "professional" politicians and parties assign better ranks to these experts – or long serving party members – to increase their odds to become a member of parliament.

With respect to saving banks, politicians can lobby upfront for an exemption ruling. This led to a suspension of the coercion to merge in the reforms in Saxony in 2008 and Mecklenburg-Vorpommern in 2011. We observe two counties in Saxony and two counties in Mecklenburg-Vorpommern that own more than one bank after the reforms. The Saxonian banks merged eventually (in 2010 and 2012) while the Pommeranian do not.[9]

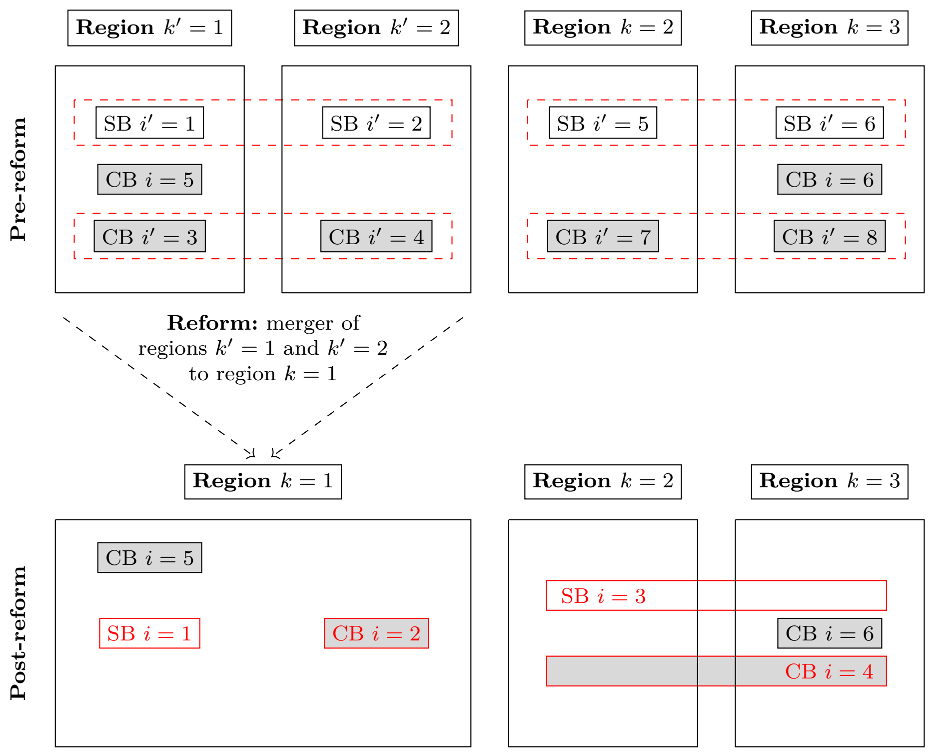
3.2.3 Identification

We illustrate the baseline as well as alternative identification strategies in Figure 3.1. In the baseline specification, we focus only on merging banks from either the cooperative or the savings bank sector, which are shown in the left-hand panel.

We start by considering only merging banks i, which reside in (pre-reform) counties k'_1 and k'_2. That is, we disregard both non-merging banks and those that merge, but do so in non-reforming counties. Our focus is thus on those counties that form a single geographical entity k – and hence owner of local savings banks – after county reforms. Observed savings banks (SB_i) mergers are therefore forced upon the management and owners of

[9]We treat these two Saxonian mergers as treated by reform which can only harm our results. As a robustness check, we split the sample in the year 2000 and use only the early reforms.

FIGURE 3.1: Identification illustrated – county reforms and bank mergers.



Notes: This figure shows savings banks (white squares) and cooperative banks (gray squares). The banks are active in regions $k' = 1, \ldots, 4$ before a regional reform. Through a regional reform, the two regions $k' = 1, 2$ merge to region $k = 1$ while the regions $k = 2, 3$ are not reformed. The savings banks $i' = 1, 2$ and cooperative banks $i' = 3, 4$ merge into savings bank $i = 3$ and cooperative bank $i = 4$ in the non-reforming regions. However, the savings banks $i' = 5, 6$ and cooperative banks $i' = 7, 8$ merge into savings bank $i = 3$ and cooperative bank $i = 4$ in the reforming regions, too. The dashed areas that span around the savings and cooperative banks before the regional reform indicated that for the analysis the banks are synthetically combined already before their mergers. The two cooperative banks $i = 5, 6$ active in reforming region $k'1 = 1$ and non-reforming region $k = 2$ do not merge.

either pre-reform, independent banking entity i' as a result of the legal requirements of the savings bank laws of the respective state. In contrast, observed cooperative bank (CB_i) mergers occur voluntarily. This identification approach therefore compares post-merger performance of the four pre-reform banks $i' = 1, 2, 3, 4$ in the upper left panel of Figure 3.1, which merge into banks $i = 1, 2$ in the lower left panel. These two banks face otherwise identical, unobserved regional conditions, such as sluggish demand for banking products that might fuel consolidation pressures. Consequently, we attribute any significant performance difference to the abandoning of having separate savings banks per county.[10]

The second identification strategy acknowledges the abundant literature on conflicting merger motives, say cherry picking versus the “silent” resolution of bank distress via pre-emptive mergers. Therefore, we sample merging

[10]We demonstrate in Table 3.3 that sampled savings and cooperative banks are for the most part not statistically different regarding the level of observable financial traits and exhibit no statistically discernible trend in any of the controls we specify and discuss below in more detail.

banks in non-reforming counties as well: $i' = 5, 6, 7, 8$ in the upper right panel depicting the non-reformed counties $k = 2$ and $k = 3$. These mergers than give rise to a new savings bank $i = 3$ and a new cooperative bank $i = 4$, each of which catering to both counties simultaneously. The post-merger performance comparison between banks $i = 1, 2, 3, 4$ relies now on both the within-county variation between savings and cooperatives as in the baseline identification and the between-county, between-merged bank variation of regions $k = 2, 3$ and $k = 1$.

In our third identification strategy, we finally include non-merging savings and cooperative banks, too. In terms of Figure 3.1, we add banks such as $i = 5, 6$ to the post-reform control group so as to assess whether savings banks that are subject to a governance shock through county reforms also unleash profitability potential relative to incumbent competitors that maintain the size of their operations.

3.3 Methodology and data

3.3.1 Methodology

To test if M&A that are induced by the rupture of political hurdles enhance profitability, we compare post-merger bank entities to a synthetic pre-merger entity. We construct the latter as follows. Almost all banks in our sample exit the market via M&A. Thus, the assets of exiting banks remain within the (savings or cooperative) banking sector and end up with one surviving bank at the end of our sample period in 2015. We identify acquiring banks as well as any subsequent acquirers up to a maximum of four layers of acquisition history for each exiting bank until we identify this ultimate survivor. For each of these surviving banks, we construct a synthetic pre-merger bank. We aggregate the assets, liabilities, and income statement positions from the first until the last available report before the M&A of all exiting banks whose acquisition history leads to the ultimate survivor bank. We then specify a difference-in-differences model to test if county-reform induced M&A unleash profitability potential among previously constrained banks:

$$\begin{aligned} \mathit{Profitability}_{i,t} = {} & \alpha_i + \delta_{s,t} + \gamma\,\mathbf{X}_{(i,c),t-1} + \beta_1 \left(\mathit{Merger}_{i,t}\right) + \beta_2 \left(\mathit{Reform}_{i,t}\right) \\ & + \beta_3 \left(\mathit{Merger}_{i,t} \times \mathit{Reform}_{i,t}\right) + \beta_4 \left(\mathit{Merger}_{i,t} \times \mathit{SB}_i\right) \\ & + \beta_5 \left(\mathit{Reform}_{i,t} \times \mathit{SB}_i\right) \\ & + \beta_6 \left(\mathit{Merger}_{i,t} \times \mathit{Reform}_{i,t} \times \mathit{SB}_i\right) + \epsilon_{i,t} \end{aligned} \tag{3.1}$$

The main dependent variable $\mathit{Profitability}_{i,t}$ is measured as the return on equity of synthetic bank i in year t residing in county c in state s, defined as the ratio of operating profits before taxes over gross book-value equity.

$\mathit{Merger}_{i,t}$ is an indicator variable equal to one in all years after a M&A. Since events occur at different points in time for each unit under observation, $\mathit{Merger}_{i,t}$ is defined in event time which is set to zero for all merging banks in the year of the merger. This is the first year in which the acquiring bank issued accounts incorporating the target and the target stopped reporting. We exclude the merger year itself from the estimation.The indicator variable equals zero up to four years before the transaction and it equals one up to four years after the event.

On average, synthetic banks merge more than once, cooperative banks even more than twice. Consequently, the treatment dummy $Reform_{i,t}$ is defined per transaction and bank. It is equal to one in the pre- and post-period if the merger took place within three years after a county reform. For example, for banks headquartered in a county in Saxony-Anhalt, which was reformed in 1994, any deal in 1994, 1995, or 1996 would be treated. By using a three year window, we account for the deadlines fixed in the reform bill (Table 3.11 shows that in case of Saxony-Anhalt 1994 this was 1^{st}January 1997) and the fact that we use end-of-year bank data.

SB_i is a dummy variable indicating if the bank is a government-owned savings bank (as opposed to a cooperative bank). The coefficient of interest is β_6 of the triple interaction term. It measures the difference in the effect of merging with or without a reform on profitability for savings relative to cooperative banks.

3.3.2 Data

We use bank-level data from annual accounts and regulatory statements, supplemented with event data on mergers and distress events provided by Deutsche Bundesbank for the period 1993 to 2015.[11] We observe the whole universe of government-owned savings and cooperative banks in Germany. The private banking sector is excluded because we cannot attribute financial data of nationwide operating private banks to local banking markets. The sample comprises 714 reporting savings banks and 2,782 reporting cooperative banks, resulting in 80,868 bank-year observations. We complement these data with macroeconomic information at the county-level provided by the Federal Statistical Office of Germany and spatial data provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), which we use to construct a reform-indicator on the county-level. We match these regional information based on the location of banks' headquarters using a county-level identifier.

We estimate Equation (3.1) with a sample of transactions, i.e., each bank included in the sample merges eventually. We accumulate all transactions of an acquirer during a year and treat them as one transaction with multiple targets. All in all, we observe 1,820 deals. These deals involve 286 savings and 1,740 cooperative banks as targets, and 182 savings and 889 cooperative banks as acquirers.[12] By considering these transactions, we capture 98.5% of all exits in the population.[13] Of these we have to discard 193 transactions because of missing covariates. Our sample consists then of 1,627 transactions, 233 of which took place in the government-owned banking sector. We observe 48 reform-induced mergers of government-owned banks and 26 reform-induced mergers of cooperative banks. Table 3.1 depicts the dynamics over time.

[11] The database on distress events is available from 1995 to 2013.

[12] About 24% of the acquiring savings banks and about 46% of the acquiring cooperative banks merge more than once. Yet some acquirers are themselves targets later on.

[13] Bank exit is defined as stopping to report total assets to Deutsche Bundesbank. Only 30 exits of regional banks over the sample period cannot be attributed to a merger. But internet search reveals that all seven savings banks that exit without record were also acquired despite the transactions not being listed in the merger data.

TABLE 3.1: Frequency distribution of banks and M&A transactions over years according to treatment and ownership status.

	Observations				Banks	Transactions			
	Savings		Cooperatives			Savings		Cooperatives	
	NT	T	NT	T	Total	NT	T	NT	T
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1993						13	2	74	2
1994	26	18	239	7	290	7	11	62	7
1995	37	18	322	10	387	1	19	43	8
1996	43	31	362	12	448	6	6	62	4
1997	56	37	389	14	496	6	1	68	0
1998	57	35	361	4	457	4	0	110	0
1999	67	25	343	0	435	11	0	126	0
2000	73	6	321	0	400	15	0	175	0
2001	83	2	408	1	494	19	0	125	0
2002	85	1	420	2	508	17	0	102	0
2003	75	0	412	0	487	27	1	83	2
2004	84	5	402	2	493	13	0	53	0
2005	74	6	346	2	428	14	0	42	0
2006	68	7	285	3	363	7	0	31	0
2007	58	8	231	3	300	4	0	21	0
2008	43	3	175	2	223	2	4	33	0
2009	35	5	152	1	193	5	2	36	1
2010	26	7	165	2	200	1	1	17	1
2011	19	8	162	3	192	3	0	17	0
2012	16	8	143	3	170	2	0	18	0
2013	14	3	122	2	141	4	1	19	1
2014	12	2	90	1	105	1	0	29	0
2015	9	1	80	0	90	3	0	22	0
Total	1,060	236	5,930	74	7,300	185	48	1,368	26

Notes: This table shows observations, number of banks, and number of M&A transactions in each year for the sample of merging banks according to treatment and ownership status. In the column headers *NT* indicates non-treated and *T* treated. In Columns (1) to (4) observations of synthetic or original banks are counted. In Column (5) observations are summed up per year giving the number of banks (original and synthetic) each year. In Columns (6) to (9) mergers are counted in the year when they occurred.

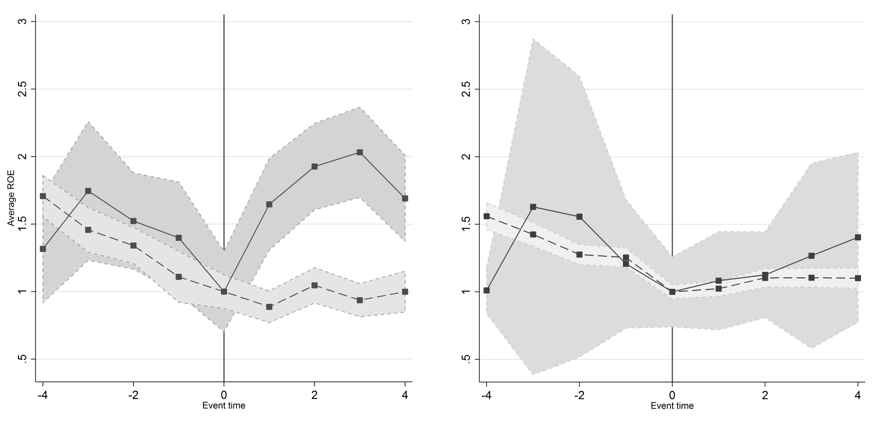
TABLE 3.2: Testing pre-merger parallel trends for return on gross equity.

	Untreated by Reform (1)	Treated by Reform (2)	Diff. in Treatment (3)	Untreated by Reform (4)	Treated by Reform (5)	Diff. in Treatment (6)
	Levels			*First-Differences*		
Savings	0.075 (0.057)	0.058 (0.045)	0.016 (0.019)	-0.010 (0.045)	-0.017 (0.055)	0.007 (0.368)
Cooperative	0.080 (0.063)	0.068 (0.050)	0.011 (0.325)	-0.004 (0.052)	0.007 (0.055)	-0.012 (0.364)
Diff. in Ownership	0.005 (0.087)	0.010 (0.448)	-0.005 (0.707)	0.006 (0.016)	0.024 (0.104)	-0.019 (0.195)

Notes: This table shows summary statistics for return on equity by ownership and treatment in the pre-merger period of merging banks. Columns (1), (2), (4), and (5) show the mean and standard deviation in parentheses. Columns (3), and (6) show the difference in means and the p-value of a difference-in-means test in parentheses.

Figure 3.2: Bank profitability around merger events by ownership and treatment status.

(a) Merging savings banks (b) Merging cooperative banks



Notes: This figure shows average Return on Gross Equity (lines) ±2 standard errors (shaded area) in event time for the sample of merging banks by ownership status; rescaled to 1 at event time 0. The solid line represents treated banks and the dashed line depicts non-treated banks.

One important concern is that savings and cooperative banks are significantly different and therefore constitute poor comparison groups. Previous studies suggest that acquirers are different from targets (Hannan and Rhoades, 1987) and that in particular stressed savings banks are merged rather than closed (Koetter et al., 2007). Hence, banks that merge voluntarily – cooperatives – might be different from savings banks that are forced to merge due to a county reform. A couple of features in our setting alleviate concerns about spurious comparisons though.

First, and most importantly, Figure 3.2 corroborates that the average profitability of treated and untreated banks within a banking group evolve similarly in the pre-merger time window, but differs starkly for savings banks only.

Table 3.2 provides a comparison of average means of the levels and first-differences of the profitability measure in the pre-merger period over treatment and ownership status. The upshot of the table is that the difference-in-differences of means is neither significant in levels nor in the slopes before the event takes place (last row in Columns (3) and (6)). Savings and cooperatives that are treated as well as untreated and treated cooperative banks do not differ significantly before the merger. Profitability differences between cooperative and savings banks that are untreated and between treated and untreated savings banks are significant though. Note, however, that the latter differences only appear in levels so that fixed effects and the covariates control for the difference.

Second, the use of synthetic pre-merger bank-entities levels out some of the performance differences between target and acquiring banks. Third, we exclude and control below for mergers where a party was in distress as a robustness test. Fourth, we are interested in the effect of the reform as an alleviation of frictions, not in the effect of merging per se. Therefore, any potential selection bias between non-merging and merging banks is less likely to bias our test.

TABLE 3.3: Summary statistics of explanatory variables by treatment and ownership status.

	Savings			Cooperative			Diff.	Diff.	Diff.
	NT	T	Diff.	NT	T	Diff.	NT	T	Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Levels									
Equity	0.046	0.039	0.007	0.053	0.048	0.005	-0.008	-0.009	-0.002
	(0.009)	(0.009)	(0.000)	(0.011)	(0.009)	(0.016)	(0.000)	(0.000)	(0.445)
LLP	0.009	0.024	-0.016	0.007	0.010	-0.003	0.001	0.014	0.013
	(0.007)	(0.014)	(0.000)	(0.009)	(0.007)	(0.070)	(0.000)	(0.000)	(0.000)
CIR	0.669	0.630	0.039	0.739	0.737	0.002	-0.070	-0.107	-0.037
	(0.068)	(0.068)	(0.000)	(0.139)	(0.080)	(0.900)	(0.000)	(0.000)	(0.067)
Liquidity	0.043	0.067	-0.023	0.064	0.097	-0.033	-0.021	-0.031	-0.010
	(0.024)	(0.022)	(0.000)	(0.028)	(0.028)	(0.000)	(0.000)	(0.000)	(0.151)
Loans	0.607	0.365	0.242	0.596	0.415	0.180	0.012	-0.050	-0.062
	(0.107)	(0.093)	(0.000)	(0.093)	(0.120)	(0.000)	(0.030)	(0.105)	(0.038)
NII	0.172	0.177	-0.005	0.184	0.232	-0.048	-0.012	-0.055	-0.043
	(0.034)	(0.052)	(0.481)	(0.058)	(0.074)	(0.009)	(0.000)	(0.005)	(0.015)
Size	4.052	3.509	0.542	3.833	3.850	-0.017	0.218	-0.341	-0.559
	(1.104)	(0.973)	(0.000)	(1.091)	(1.089)	(0.946)	(0.000)	(0.230)	(0.044)
Log(GDP)	8.594	8.161	0.433	8.405	8.467	-0.062	0.190	-0.306	-0.495
	(0.902)	(0.667)	(0.000)	(0.778)	(0.818)	(0.740)	(0.000)	(0.146)	(0.016)
First-Differences									
Equity	0.001	0.000	0.000	0.001	0.000	0.001	-0.000	-0.000	0.000
	(0.002)	(0.002)	(0.137)	(0.002)	(0.003)	(0.332)	(0.000)	(0.636)	(0.841)
LLP	0.000	0.004	-0.003	-0.000	-0.002	0.002	0.000	0.006	0.006
	(0.007)	(0.015)	(0.102)	(0.009)	(0.009)	(0.300)	(0.260)	(0.040)	(0.049)
CIR	0.007	-0.031	0.039	0.004	-0.027	0.030	0.004	-0.005	-0.008
	(0.057)	(0.094)	(0.005)	(0.141)	(0.058)	(0.033)	(0.356)	(0.794)	(0.648)
Liquidity	0.002	-0.003	0.005	0.000	-0.007	0.007	0.001	0.004	0.003
	(0.019)	(0.020)	(0.119)	(0.024)	(0.033)	(0.338)	(0.152)	(0.602)	(0.723)
Loans	0.001	0.009	-0.008	0.002	0.010	-0.008	-0.001	-0.002	-0.000
	(0.019)	(0.023)	(0.022)	(0.023)	(0.024)	(0.156)	(0.193)	(0.811)	(0.969)
NII	0.005	0.007	-0.002	0.006	-0.001	0.006	-0.000	0.008	0.008
	(0.017)	(0.016)	(0.382)	(0.045)	(0.025)	(0.271)	(0.759)	(0.188)	(0.156)
Size	-0.002	-0.057	0.054	-0.002	0.050	-0.052	-0.000	-0.107	-0.106
	(0.213)	(0.305)	(0.210)	(0.188)	(0.394)	(0.565)	(0.966)	(0.284)	(0.269)
Log(GDP)	0.020	0.073	-0.054	0.027	0.062	-0.035	-0.007	0.012	0.019
	(0.033)	(0.065)	(0.000)	(0.035)	(0.072)	(0.045)	(0.000)	(0.530)	(0.304)

Notes: This table shows summary statistics of explanatory variables by ownership and treatment in the period before the merger. In the column headers *NT* indicates non-treated and *T* treated. Columns (1), (2), (4), and (5) show means and standard-deviation in parentheses by treatment and ownership. Columns (3), and (6) show the difference in means by treatment with p-value of t-test in parentheses within each banking sector. Columns (7), and (8) show the difference in means by ownership with p-value of t-test in parentheses within treatment status. Column (9) shows the difference-in-differences with p-value of t-test in parentheses. Equity, Loan Loss Provisions (LLP), Liquidity, and Loans are defined as ratios to total assets. Non Interest Income (NII) is defined as ratio relative to interest-bearing assets. Size is a categorical variable indicating the quintile of the banking groups size distribution in terms of total assets. Cost-Income-Ratio (CIR) is defined as administrative costs to total income. L(GDP) is the logarithm of GDP at the county level of the bank's headquarters.

We control by the matrix $\mathbf{X}$ in Equation (3.1) for macroeconomic and bank-specific conditions, which are defined in Appendix Table 3.22. Bank-level fixed effects account for unobserved time-invariant heterogeneity across banks. To address time-varying variation between banks, we add CAMEL financial ratios, proxies for banks' business models, and size (Wheelock and Wilson, 2000). Summary statistics in Table 3.3 show that despite some significant differences in the differences of levels (Column (9) upper part), the difference-in-differences of the slopes of all covariates except loan loss provisions are insignificant (Column (9) lower part).

We measure financial profiles with (i) the equity to total assets ratio to gauge capital adequacy (*Equity*), (ii) loan loss provisions to total loans for asset quality (*LLP*), (iii) cost-income-ratio for management quality (*CIR*), and (iv) liquid to total assets for liquidity profile (*Liquidity*). In the baseline estimation, we exclude proxies for earnings because these are strongly correlated with the dependent variable. To capture the business model we add (v) consumer loans to total assets ratio (*Loans*), and (vi) non-interest-income to total income (*NII*). Finally, we specify (vii) size as an annual decile indicator of the total asset distribution (*Size*). All covariates are lagged by one year. To account for macroeconomic differences, which affect business opportunities and the demand for banking services, we add year × state fixed effects. In addition, we control for GDP at the county-level, which is one of the few macroeconomic measures also available at granular regional levels in Eastern Germany since the early 1990s.

3.4 Effects of reform-induced mergers on bank performance

3.4.1 Profitability sclerosis

Table 3.4 shows our baseline regression results from estimating Equation (3.1). We start in Column (1) with a sample of merging banks that resided only in reformed counties. In terms of the illustration in Figure 3.1, we thus consider banks $i' = 1, 2, 3, 4$ in the upper left panel. The results in Column (1) show that our coefficient of interest, the triple interaction term β_6 between government ownership, the occurrence of a merger, and a spatial reform affecting banks' home counties, is positive and statistically significant.

In fact, the economic magnitude of this "unleashing potential" effect is large. Government-owned savings banks that merge after a county reform exhibit a positive differential return of equity (RoE) effect on the order of 5.7 percentage points relative to the comparison group. The peers to which we compare post-merger performance in Column (1) are not-yet-merged savings and cooperative banks before the reform. The total relative effect of the reform on savings bank profitability is a third of a percentage point $(-0.024+0.057)$. Compared to a sample mean RoE of 7.9%, this estimate implies that savings banks increase their RoE after a reform-induced merger relative to other merging banks that are still in the pre-merging period by roughly 41%. In contrast, cooperative banks – which are not subject to any potential political frictions that held them back from realizing optimal profits prior to the county reform – exhibit a RoE effect that is 2.4 percentage points lower than before the reform.

These results are unlikely to reflect fundamentally different business models between savings and cooperative banks, which are absorbed by bank-fixed effects. In addition, recall that we specify time-varying control variables at both the bank- as well as the county-level, which limits the danger that other (time-variant) unobserved effects bias our estimate. Another concern is that county reforms may not occur randomly but correlate, for example, with electoral and/or budgetary cycles at the national and sub-national level of the states.[14] Dire state-specific macro and credit demand conditions could ignite both county reforms and bank mergers. Because of this valid potential reservation, we specify state-by-year fixed effects. Thereby, the coefficients in Table 3.4 result from a within state-year comparison of banks which controls for between-state differences in terms of economic surroundings, political

[14] See, for example, Seitz (2000) and Galli and Rossi (2002) for evidence at the sub-national level of German states and Katsimi and Sarantides (2012) or Efthyvoulou (2012) for national evidence in Europe.

TABLE 3.4: Baseline results: Effect of reform-induced mergers on ROE.

	Merging Reformed (1)	Merging (2)	Incl. Non-merging (3)
Merger	0.001	-0.003*	0.000
	(0.002)	(0.001)	(0.001)
Reform	0.011*	0.007	-0.003
	(0.007)	(0.007)	(0.007)
Merger*Reform	-0.024***	-0.016**	-0.016**
	(0.008)	(0.008)	(0.008)
Merger*SB	-0.014**	-0.014***	-0.011***
	(0.006)	(0.004)	(0.003)
Reform*SB	-0.006	-0.008	0.005
	(0.013)	(0.012)	(0.008)
Merger*Reform*SB	0.057***	0.056***	0.038***
	(0.015)	(0.013)	(0.011)
Observations	2,441	7,300	20,893
Banks	291	788	1,438
Savings Banks	85	163	414
Cooperative Banks	206	625	1,024
Treated Deals	74	74	74
Non-treated Deals	466	1,553	1,553
Mean	0.079	0.078	0.083
Median	0.075	0.078	0.078
Standard Deviation	0.056	0.062	0.067
Bank & County Controls	yes	yes	yes
Bank, Year-State FE	yes	yes	yes
R-squared (within)	0.415	0.324	0.322

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Difference-in-differences estimation with a 4 year event window (pre- and post-merger) where all available observations within the window are included. Merger is a dummy indicating the post-period. Reform is a dummy indicating the treatment status constant over event time for any transaction. In Column (1) only banks merging in Eastern Germany, Lower Saxony, and North-Rhine-Westphalia are included. In Column (2) all merging banks are included. In Column (3) all banks are included and the treatment status of the Reform dummy lasts 8 years before and after a reform for non-merging banks. Bank controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, Size, and L(GDP) at the county-level. Equity is excluded due to collinearity.

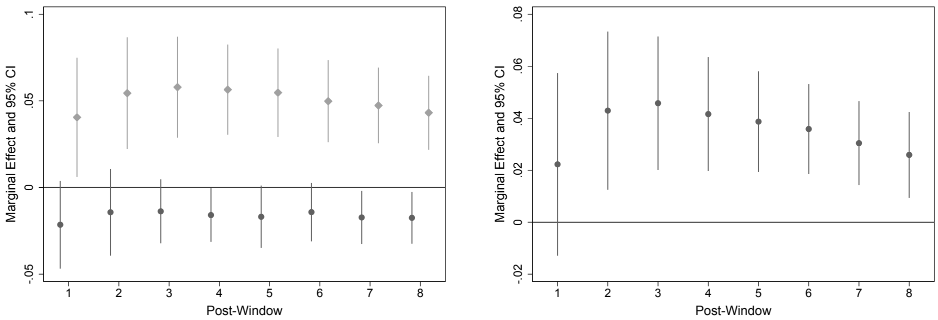
influences, and other unobservable demand effects. Given this encompassing saturation of the model with fixed effects to gauge unobservable drivers of post-merger bank profitability, it is remarkable that the within-county variation in covariates identifies around one third of the total variation in bank RoE.

The tight specification in Column (1) provides a very clean identification of the RoE differential effect. But it does not permit any inference beyond locally merging banks in counties that actually experienced a spatial reform at some stage.[15] Since the majority of reforms – and hence reform-induced mergers – pertain to Eastern-German states (see Table 3.11), we expand the control group in Column (2) by merging savings and cooperative banks from non-reforming counties. This specification therefore also gauges cases of savings (and cooperative) bank mergers that occurred without an exogenous change forced upon the local politicians that own savings banks, and thus the governance exerted by them. This specification is based on a sample of

[15] We provide details on alternative samples in Tables 3.19 and 3.20.

FIGURE 3.3: Long term effects on profitability.

(A) Double and triple interaction effect (B) Differential effect



Notes: This figure shows the effect of reform on merging savings banks for different time windows (0-8). The dots depict the coefficient estimates and the solid lines the 95% confidence intervals.The left graph displays the double and triple interaction effect, i.e., β_3 (dark gray) and β_6 (light gray) in Equation (3.1). The right graph shows the differential effect of reform on the effect of merging for savings banks, i.e., $\beta_3 + \beta_6$ in Equation (3.1).

bank-year observations that is almost three times as large, yet yields virtually identical results concerning statistical significance, direction of effects, as well as economic magnitudes.

An alternative scenario why government bank performance is unleashed is that county reforms themselves lead to profitability improvements. It is not unreasonable to suspect that county reforms in pursuit of unrealized administrative efficiency gains extend in particular to banks supervised and owned by that very government. As such, any profitability gains from ceased political frictions would apply to non-merging savings banks as well. In that case, confining the sample to merging banks might give rise to spurious RoE effects of reform-induced consolidation. To test if RoE effects are at work through the elimination of excess capacities due to enforced mergers, we therefore also include banks that did not merge at all in Column (3). In terms of Figure 3.1, this specification corresponds to banks $i = 5, 6$. The main effects remain qualitatively intact for this sample as well, although the economic magnitude of both the total effect of reforms as well as the triple differential effect reflected by β_6 is somewhat smaller. Overall, these results corroborate the robustness of the main findings: savings banks are significantly more profitable after a merger that was induced by a county reform. Henceforth, we focus on the specification in Column (2), which compares only merging savings and cooperative banks, however from both reformed and non-reformed counties.

The headline result implies, that a reduction of political frictions induced by county mergers increases the profitability of savings banks by fueling consolidation in this part of the banking sector. In light of alleged excess capacities prevailing in European banking (ESRB, 2014), increased direct and indirect government stakes in European banks after the Great Financial crisis, and notoriously low profitability, the reduction of political governance frictions appears an effective and potentially important way forward for the financial industry.

An important open issue to completely assess the potential policy implications of our results is whether reform-induced mergers actually yield sustained profitability improvements compared to other merging banks that did not experience a hike in governance pressure. Therefore, we specify increasingly long post-merger reform periods to assess if and for how long reform-induced M&A enhance RoE. Figure 3.3 plots these effects for post-reform periods of up to eight years.

The left panel depicts estimated double and triple interaction effects and corresponding 95% confidence intervals based on estimations of Equation (3.1) for the main sample (Column (2) in Table 3.4) across increasing lag lengths that are depicted on the x-axis. The differential RoE effect between government- and cooperative banks remains significant for up to eight years after a reform-induced merger. The right panel plots the overall effect of county reforms on the profitability of savings bank, which is also significantly positive for the entire period. Thus, the profitability improvements of government-owned banks that are unleashed by removing the political shelter prior to county reforms do not vanish quickly. Instead, profitability gains are statistically significant and economically meaningful for a considerable period of time.

3.4.2 Robustness of the effect on profitability

We conduct a number of robustness checks for our baseline results and provide all corresponding tables in the Appendix.

First, Table 3.13 shows regression results for different bank profitability measures and alternative samples. For comparison, Column (1) provides the regression results for the sample of merging banks in all counties from Table 3.4. We check in Columns (2) and (3) whether our results hinge on the choice in our baseline regression to use gross equity in the denominator of bank profitability. Gross equity contains some reserve positions that allow for fairly particular valuation treatments under German accounting rules according to the commercial code (*Handelsgesetzbuch*). Therefore, we also gauge profitability relative to net equity or total assets. In both cases, the triple interaction term remains positive and significant, which confirms that savings banks become more profitable compared to cooperative banks after county reforms. Columns (4) and (5) test whether the headline results are driven by a particular time period. Since most of the county reforms took place in the 1990s, Column (2) provides results for the years from 1994 until 2000. The results are qualitatively almost identical regarding significance and magnitude compared to the baseline case. However, when we confine the analysis to the years between 2000 and 2009, the results are insignificant. This feature mirrors the fact that much fewer county reforms that affected a substantially smaller number of banks took place after the turn of the century. Next, we exclude distressed banks from the sample in Column (6) of Table 3.13. Supervisory orders to restructure might be a confounding channel to unlock profitability potential after successful recovery of the merged entity (Kick et al., 2016). The size of the triple interaction term declines to an increase of RoE on the order of 4.6 percentage points. This result therefore still indicates an economically large role played by regional government ownership acting as a roadblock to unlocking profitability potential. In Column (7) we acknowledge that savings banks might be connected to local politicians to varying degrees through credit connections. We therefore exclude banks with a municipality lending share of total loans above the average of their banking groups to account for possibly very close political ties in Column (7). This specification leaves the main results untouched as well. Finally, we sample in the vein of Huang (2008) only banks from reforming counties and banks from adjacent non-reforming counties. This contiguous county specification ensures that those unobservable factors possibly not captured by the fixed effects are muted. Column (8) shows that savings banks still exhibit higher profitability after reform-induced mergers. In Column (9) we addresses possible concerns related to the time-series correlation of bank mergers and profitability in our sample. A typical concern with difference-in-difference regressions applied to panel data with many periods is correlation of the dependent variable. In such a case, standard errors may be low enough to imply a systematic over-rejection of the null hypothesis of differential effects after the treatment (Bertrand et al., 2004). Note that the merger events analyzed here do not occur for all banks in one particular year. Therefore, the pre- and post-periods are not equal for each treated and control bank. Consequently, a standard OLS regression on the collapsed sample is inadequate. We follow Bertrand et al. (2004) and regress the dependent variable RoE on the covariates, fixed effects, and the reform indicator, which defines the treatment status. Only the residuals of the treated banks are then distinguished into two groups, thereby eliminating the time dimension: residuals from the pre-reform years and residuals from post-reform years. Column (9) shows results where we estimate the impact of the reform on the treated banks in this two-period panel. The interaction effect of the merger indicator and the indicator that separates savings from cooperative banks are both significant. Consequently, this procedure to eliminate potential concerns regarding serial dependence contaminating our estimates does leave our main effect of interest intact.

Second, in Table 3.12 we provide results from placebo reform treatments to verify whether the differential effect in returns was induced by reform or chance. We run two simulations with 1,000 replications and extract the probabilities to be treated by reform for each banking group separately. We separate by banking group because the probability to be treated for savings banks is significantly higher than for cooperative banks. The reason is that most of the reforms took place in Eastern Germany, but there exist disproportionally more cooperative banks in Western Germany and especially in the South of Germany. If we were not to account for these differences, we would over-sample cooperative banks. We assign reform treatment randomly over all years to other merger events, re-estimate our baseline specification (corresponding to Column (2) in Table 3.4) and test in each repetition the hypothesis that the coefficient on the triple interaction between reform, post-merger and government owned bank is equal to 0. We calculate the rejection rates of this test at 1%, 5%, and 10%, which are shown in Table 3.12. We assign treatment randomly over all reporting banks, including those that were actually treated. Overall, Table 3.12 shows for these random placebo treatments that our main effect is only significant within the range of statistical noise. This outcome thus strongly supports our results from Table 3.4. The RoE increase due to county-reform induced mergers is very unlikely just due to statistical noise driven by other factors than the actual county reforms followed by reform-induced bank mergers.

3.4.3 Decomposition and economic channels of the effect on profitability

At first sight, profitability improvements after reform-induced mergers bode well to enhance the resilience of the EU banking system, which exhibits sclerotic profitability developments since the Great Financial crisis. In this section, we seek to shed light on possible channels of positive bank RoE effects. We begin by decomposing Return on Equity from an accounting perspective to identify the source of profitability hikes: equity, profits, and cost. Then we test for economic drivers documented in previous literature that determine post-merger performance: risk, efficiency, and market power.

A simple way to improve the profitability in terms of RoE is to increase leverage, clearly an undesirable strategy from a financial stability perspective if this risk-taking turns excessive. Table 3.5 therefore provides a decomposition of a bank's gross equity positions, which is the numerator of our main performance metric. We reproduce the main results for return on equity in the first column and show subsequently results for gross equity and its components: net equity, accruals, and other equity. We specify the log level of these level variables to accommodate the heterogeneous distribution in absolute sizes and so as to ease the interpretation of coefficients as semi-elasticities.

County reform-induced mergers exert no significant differential effect on banks' gross equity (Column (2)), but decrease savings banks' net equity position significantly. Column (3) show that compared to cooperative banks, savings banks' net equity decreases by around 8.6% by the reform-induced merger. We provide more detailed results in Table 3.14 in the Appendix. Here, we find that the decrease in net equity is potentially driven by nominal equity (Column (2)) and retained earnings from the current accounting period (Column (5)). Both coefficients are negative, too, which might indicate that the new owners of the merged entity force it to disperse some of its accumulated earnings. Note, however, that in the more detailed decomposition the individual effects are not statistically significant.

The two remaining components in Table 3.5 that are part of gross equity are accruals and other equity. Column (4) shows that there is no significant triple interaction effect indicating that accruals are not driving our results. However, Table 3.14 in the Appendix highlights that this absence of an effect is likely the result from counteracting effects of increasing tax accruals and decreasing accruals for risk. The latter effect reflects lower loan loss provisions and a reduction in accruals for pensions. Again, the low power that poses challenges to estimate a statistically significant effect prohibits stronger inference. However, a possible narrative in line with these indications is that merged banks increase their operational risks as far as retaining earnings to cover the potential realizations of risks in the distant future – like pension obligations and more conventional credit risk – is concerned. At the same time, they might receive advantageous tax treatments that are reflected in increasing equity accruals for taxes.[16]

The residual category is other equity. The triple interaction coefficient is significantly negative and at first sight very large. But the magnitude of

[16] An important share of corporate taxes are levied at the level of counties (Statistische Ämter des Bundes und der Länder, 2014, *Gemeindesteuer*), which correlate with the political cycle (Foremny and Riedel, 2014).

TABLE 3.5: Reform effects on equity and its components of merging banks.

	RoE (1)	L(Gross Eq) (2)	L(Net Eq) (3)	L(Accruals) (4)	L(Other Eq) (5)
Merger	-0.003*	-0.014***	-0.006*	-0.008	-0.299***
	(0.001)	(0.004)	(0.004)	(0.008)	(0.116)
Reform	0.007	0.045	0.037	0.130	-1.954
	(0.007)	(0.040)	(0.024)	(0.113)	(1.844)
Merger*Reform	-0.016**	0.045	0.026	-0.115	2.398
	(0.008)	(0.042)	(0.023)	(0.097)	(1.690)
Merger*SB	-0.014***	-0.021*	-0.014	0.029*	0.347*
	(0.004)	(0.013)	(0.010)	(0.017)	(0.197)
Reform*SB	-0.008	-0.250***	-0.039	-0.258*	0.990
	(0.012)	(0.069)	(0.046)	(0.142)	(1.704)
Merger*Reform*SB	0.056***	-0.007	-0.086**	0.091	-3.571**
	(0.013)	(0.057)	(0.034)	(0.124)	(1.675)
Observations	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788
Mean	0.08	17.66	17.32	15.59	14.39
Median	0.08	17.56	17.25	15.55	15.37
Standard Deviation	0.06	1.15	1.08	1.24	4.41
Bank & County Controls	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes
R-squared (within)	0.324	0.816	0.818	0.624	0.163

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Difference-in-differences estimation with a 4 year event window (pre- and post-merger) where all available observations within the window are included. Merger is a dummy indicating the post-period. Reform is a dummy indicating the treatment status constant over event time. Controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, Size, and L(GDP). Dependent variables are logarithms and defined as: *Gross Eq* is *Net Eq* plus *Accruals* plus *Other Eq*. *Net Eq* is nominal equity plus retained earnings. *Accruals* are total accruals, including accruals for pensions, taxes and those formed by loan loss provisions. *Other Eq* is other equity including subordinated debt and other Tier 2 equity.

350% must be regarded in the light of a very high difference in this category between savings and cooperative banks in the pre-treatment period. As Table 3.18 in the Appendix shows, this pre-treatment difference is about 576%. This result therefore rather indicates that mergers induced by county reforms alleviate some of these pre-treatment differences. The more detailed breakdown provided in Table 3.14 indicates that the overall effect appears to be primarily driven by an increase in subordinated debt.

In sum, an important source of increasing return on equity appears to accrue amongst merging savings banks from choosing lower capitalization ratios. Clearly, this might result from previously too high levels of capital that were inefficient. Whereas we cannot, of course, evaluate with our approach the adequacy of capital levels, we conclude that *ceteris paribus* improved post-merger bank performance results from accepting also more risky balance sheet structures.

If county reforms are the (positive) governance shock that we conjecture it to be, we should see in particular profits to increase and costs to be cut as a consequence of rectifying previously amassed operational slack, for example due to a Hicksian quiet life (see Koetter et al., 2012a, for evidence how U.S. regulation sheltered banks from enforcing efficient operations). Therefore, we turn next to the numerator of bank RoE and investigate banks' revenues, profits, and cost components in Table 3.6. All variables are specified again in log-levels.

Column (1) shows that besides reducing capitalization, merged savings banks in reformed counties also substantially increased their profits before taxes. Mergers that are induced by county reforms increased savings banks'

TABLE 3.6: Reform effects on profit and its components of merging banks.

	L(Profit) (1)	L(Total Rev) (2)	L(Op Rev) (3)	L(Non-Op Rev) (4)	L(Total Cost) (5)	L(Op Cost) (6)	L(Non-Op Cost) (7)
Merger	-0.102	-0.007**	-0.005	-0.898***	-0.005	-0.010***	-0.109*
	(0.091)	(0.004)	(0.003)	(0.166)	(0.004)	(0.003)	(0.062)
Reform	0.971	0.022	0.035	-1.426	0.017	0.021	-0.071
	(0.916)	(0.032)	(0.029)	(1.442)	(0.031)	(0.027)	(0.191)
Merger*Reform	-0.174	0.043	0.027	2.705	0.049	0.032	0.028
	(0.856)	(0.030)	(0.026)	(1.714)	(0.030)	(0.029)	(0.272)
Merger*SB	-0.319	-0.032***	-0.023***	-1.688***	-0.014	-0.005	0.139
	(0.203)	(0.008)	(0.008)	(0.531)	(0.009)	(0.008)	(0.104)
Reform*SB	-2.749**	-0.094**	-0.093***	0.682	-0.071*	-0.076**	0.276
	(1.249)	(0.038)	(0.036)	(1.783)	(0.039)	(0.035)	(0.269)
Merger*Reform*SB	3.285***	-0.027	-0.020	-0.915	-0.077**	-0.044	-0.232
	(1.223)	(0.038)	(0.035)	(2.026)	(0.038)	(0.038)	(0.343)
Observations	7,300	7,300	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788	788	788
Mean	14.26	17.57	17.55	9.54	17.48	17.39	14.62
Median	14.99	17.49	17.47	11.81	17.39	17.3	14.74
Standard Deviation	3.6	1.08	1.08	5.71	1.08	1.07	1.96
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.150	0.420	0.455	0.301	0.549	0.575	0.245

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Difference-in-differences estimation with a 4 year event window (pre- and post-merger) where all available observations within the window are included. Merger is a dummy indicating the post-period. Reform is a dummy indicating the treatment status constant over event time. Controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, Size, and L(GDP). The dependent variables are logarithms and defined as: *Profit* is profit before taxes. *Total Rev* are total revenue and *Total Cost* are total costs. *Op Rev* are operating revenues, consisting of revenues earned on interest, commissions and fee income, revenues earned on the trading book, other operating revenues, and current revenues. *Op Cost* are operating costs, consisting of interest expenses, costs from commissions and fees, costs from the trading book, other operating costs, and administrative costs. *Non-Op Rev* are non-operating revenues consisting of appreciations and extraordinary revenues. *Non-Op Cost* are non-operating costs, consisting of depreciation and extraordinary costs.

TABLE 3.7: Reform effects on financial stability of merging banks.

	L(zscore) (1)	SD(RoA) (2)	Tier1 (3)	LLP (4)	NPL (5)
Merger	0.014	-0.000	0.000**	0.000	0.000
	(0.033)	(0.000)	(0.000)	(0.000)	(0.001)
Reform	0.460	-0.000	-0.001	-0.004	-0.046**
	(0.300)	(0.001)	(0.002)	(0.003)	(0.023)
Merger*Reform	-0.123	-0.000	-0.001	0.006*	-0.011
	(0.274)	(0.000)	(0.002)	(0.004)	(0.017)
Merger*SB	0.285***	-0.000**	0.001**	-0.001	0.001
	(0.088)	(0.000)	(0.000)	(0.000)	(0.002)
Reform*SB	-0.197	-0.001	0.002	0.008**	0.034
	(0.333)	(0.001)	(0.002)	(0.004)	(0.025)
Merger*Reform*SB	-0.187	0.001**	-0.003	-0.012***	0.030*
	(0.292)	(0.001)	(0.002)	(0.004)	(0.018)
Observations	7,206	7,206	7,300	7,300	5,153
Banks	788	788	788	788	748
Mean	3.65	0.00	0.05	0.01	0.06
Median	3.60	0.00	0.05	0.01	0.05
Standard Deviation	0.84	0.00	0.01	0.01	0.05
Bank & County Controls	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes
R-squared (within)	0.127	0.169	0.751	0.235	0.426

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Lagged covariates are L(GDP) at the county-level, CIR, Liquidity, NII, Loans, and Size at the bank-level. In Columns (4) to (5) Equity, and in Columns (3) to (5) RoA is added as a control. LLP is excluded as a control due to endogeneity. Dependent variables are: *zscore* is defined as return on assets minus *Tier 1* ratio over *SD(RoA)*. *SD(RoA)* is the standard deviation of return on assets calculated with a rolling window of three years which results in a drop of observations in Column (1) and (2). *Tier 1* is the ratio of regulatory Tier 1 equity to total assets. *LLP* are loan loss provisions. *NPL* are non-performing loans over total loans. *NPL* are available from 1999-2015 which causes the drop in observations and reduces the number of treated deals to 39 and the number of non-treated deals to 1,245.

profits by about 330% compared to cooperative banks. This increase in profits is not due to an increase in revenues (Column (2)), but due to lower total costs that savings banks incur relative to their cooperative counterparts after county reform-induced mergers. Our findings are corroborated by Table 3.15 which confirms that the revenues of treated banks are barely affected by the county-reforms. But Table 3.16 shows that lower costs of savings banks are mainly driven by reduced interest expenses and other operating costs.

Besides the somewhat mechanistic decomposition of bank profitability from an accounting perspective, we test three economic channels proposed in previous literature as determinants of post-merger performance. Against the background of well-known risk-taking incentives associated with increasing banking market concentration (see, for example, Keeley, 1990; Repullo and Martinez-Miera, 2010), a first important question is whether or not the improved profitability of savings banks after reform-induced mergers also bears implications for overall bank risk.

We document in Table 3.7 that higher profitability are associated with significantly more volatile return on assets (Column (2)). But in combination with unchanged Tier 1 capital ratios (Column (3)), the reform-induced mergers have no significant differential effects on banks' z-scores. What we do find is a significant reduction in loan loss provision shares and an increase in

Table 3.8: Reform effects on efficiency of merging banks.

	Branch (1)	Empl (2)	Empl/ Branch (3)	Wages/ Empl (4)	CIR (5)
Merger	-0.003	0.008	-0.218	0.001	-0.009***
	(0.003)	(0.005)	(0.441)	(0.001)	(0.003)
Reform	-0.011	0.001	1.102	-0.002	-0.019
	(0.062)	(0.010)	(1.750)	(0.002)	(0.014)
Merger*Reform	0.035	-0.017	-1.040	-0.008**	0.004
	(0.041)	(0.012)	(1.659)	(0.004)	(0.020)
Merger*SB	0.031***	-0.017*	19.527**	-0.001	0.026***
	(0.006)	(0.009)	(9.880)	(0.001)	(0.005)
Reform*SB	-0.084	-0.021*	8.103*	0.007*	0.035*
	(0.059)	(0.012)	(4.557)	(0.004)	(0.019)
Merger*Reform*SB	0.007	0.050***	-18.130*	0.008*	-0.021
	(0.045)	(0.015)	(9.475)	(0.004)	(0.024)
Observations	6,958	7,228	6,958	7,228	7,300
Banks	788	788	788	788	788
Mean	0.43	0.3	10.5	0.11	0.73
Median	0.38	0.29	8.11	0.07	0.71
Standard Deviation	0.27	0.08	19.22	0.13	0.13
Bank & County Controls	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes
R-squared (within)	0.127	0.169	0.751	0.235	0.426

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Lagged covariates are L(GDP) at the county-level, Equity, LLP, RoA, Liquidity, NII, Loans, and Size at the bank-level. In Columns (1) to (4) CIR is added as a control. Dependent variables are: *Branch* is the ratio of number of branches to total assets in millions. *Branch* is available from 1993-2012 resulting in a drop of observations in Columns (1) and (3). *Empl* is the ratio of number of employees over total assets in millions. *Empl* is missing for many banks in 2015 resulting in a drop of observations in Column (2) and (4). *Empl/Branch* is the average number of employees per branch. *Wages/Empl* is the average personnel costs spend per employee. *CIR* is the cost-income-ratio.

non-performing loan shares for savings banks in comparison to cooperative banks though. In economic terms, our results suggest that the overall effect of reform-induced mergers on savings banks is a reduction of loan provisions of about 0.6 percentage points and an increase of non-performing loans of 1.9 percentage points. In light of mean values of 0.01 for provisions and 0.06 for non-performing loans, these effects display a change in economic magnitude of about two and one third for both measures, respectively. Consistent with the relative reduction of capitalization, this increase in credit risk indicates that the realization of profitability potential is generally associated with more risky financial profiles compared to pre-merger conditions.

The second channel relates to the role of cost efficiency as an important reason for consolidation, for example by eliminating excess employment of labor or physical capital in the form of branches (Lang and Welzel, 1999) or the plain realization of scale economies (Berger et al., 1999).

Table 3.8 shows accordingly the effects of reform-induced mergers on the number of branches and the number of employees (both in relation to total assets), the ratio of employees per branch, wages per employee, and the cost-income ratio.

Column (1) shows that there is no significant reduction of the number of branches relative to bank size for government- and cooperative banks.

Table 3.9: Reform effects on market power of merging banks.

	NIM (1)	Int. earned (2)	Int. paid (3)	L(IBA) (4)	Market share (5)
Merger	0.000***	0.000***	0.000	-0.011***	-0.000
	(0.000)	(0.000)	(0.000)	(0.004)	(0.001)
Reform	-0.001	-0.001	-0.000	0.034	0.015
	(0.001)	(0.001)	(0.001)	(0.029)	(0.017)
Merger*Reform	-0.001	0.001	0.001*	0.060*	0.013
	(0.001)	(0.001)	(0.001)	(0.032)	(0.014)
Merger*SB	-0.000	-0.000	-0.000	0.000	0.002
	(0.000)	(0.000)	(0.000)	(0.009)	(0.005)
Reform*SB	0.002	0.000	-0.002*	-0.102***	-0.142***
	(0.001)	(0.001)	(0.001)	(0.039)	(0.046)
Merger*Reform*SB	0.003***	0.003**	-0.000	-0.101***	-0.004
	(0.001)	(0.001)	(0.001)	(0.039)	(0.031)
Observations	7,300	7,300	7,300	7,300	6,965
Banks	788	788	788	788	788
Mean	0.03	0.06	0.03	20.21	0.15
Median	0.03	0.06	0.03	20.13	0.08
Standard Deviation	0.01	0.01	0.01	1.1	0.18
Bank & County Controls	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes
R-squared (within)	0.687	0.949	0.949	0.602	0.194

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Lagged covariates are L(GDP) at the county-level, Equity, LLP, CIR, Liquidity, and Size at the bank-level. In Column (5) RoA and NII are added as control variables. Dependent variables are: *NIM* is the net-interest-margin, defined as *Int earned* minus *Int paid* over *IBA*. *Int earned* are interest revenues over total income. *Int paid* are interest costs over total income. *IBA* are interest bearing assets consisting of loans to customers and banks and securities. *Market share* is the market share of loans to customers of a bank within its business area. Business area is defined by aggregating all counties where a bank has branches. Total loans on the bank-level are split among counties according to the share of own branches located in that county. Branch data is available from 1993-2012 resulting in a drop of observations in Column (5).

Furthermore, savings banks have more staff relative to bank size than cooperative banks after the reform-induced mergers (Column (2)). However, when we contrast employees with branches we find that savings banks manage to reduce the number of employees per branch by roughly 80% compared to the group of cooperative banks (Column (3)). This reduction is cost neutral since the overall effect on labor cost (wages per employee) for savings banks is zero (Column (4)). Last, Column (5) of Table 3.8 shows that the differential effect on the cost-income ratio between government- and cooperative banks is negative but insignificant. Thus, cost reductions do not seem to result in a significant higher efficiency of savings banks after reform-induced mergers.

The third economic channel of potential importance is that banks merge so as to gain market power, thereby permitting them to extract rents either from mere monopoly power (Canales and Nanda, 2012) or enhanced abilities to generate and use private information from larger average customer pools per bank (Hauswald and Marquez, 2006). To test for any post-merger market power implications, we therefore explore net interest margins and its components and the market share of banks in terms of loans to customers of a bank within its business area. We provide the results in Table 3.9.

Our results suggest that the net interest margin serves as an explanation for the higher profitability ratio for savings banks. Reform-induced mergers of government-owned banks lead to an increase of 0.2 percentage points, which is significantly higher compared to the change of cooperative banks (Column (1)). Relative to mean net interest margins on the order of 3 percentage points, this estimated magnitude amounts to an increase by 6.7%. We further find that the higher net interest margin results from an increase of interest income (Column (2)). Interest expenses, in turn, remain statistically unchanged (Column (3)). At the same time, our results further indicate that savings banks decrease their interest bearing liabilities significantly (Column (4)). This result suggests that those banks manage to increase interest income ratios with fewer interest bearing assets. The more detailed analysis of components in Table 3.17 in the Appendix shows that the reduction of interest bearing liabilities reflects lower customer loans and investments in bonds and securities of savings banks after reform-induced mergers. Finally, Column (5) of Table 3.9 shows that reform-induced merges do not enable savings banks to gain market shares compared to cooperative banks.

3.5 Real effects of reform-induced bank mergers

So far, the evidence univocally suggests a positive differential effect on bank profitability after reform-induced mergers. But it remains an open question whether the elimination of political hurdles is desirable from the perspective of real economic implications. To this end, we consider next both banks' and non-financial firms' responses in greater detail.

3.5.1 Bank responses

First, we address the question whether and how the hike in profitability of reform-induced merged savings banks is associated with some frequently voiced concerns that such a consolidation brings along: the limited provision of access to financial (retail) services in non-urban areas, support of local economic policy-makers, and constrained credit access especially for SMEs. Therefore, we specify according in the baseline Equation (3.1) alternative dependent variables.

Column (1) of Table 3.10 refers to results specifying retail deposits of savings banks as the dependent variable. For the lack of more direct measures of providing financial services to retail customers, we want to gauge if savings banks that merged after a county reform offer fewer retail customer accounts and rely instead on more wholesale-oriented sources of funding that do not require to administer many relatively small denomination accounts. We do not find any such tendency. The triple interaction term of the merger indicator, the county reform dummy, and the savings bank indicator shows no significant difference relative to the comparison group of cooperative banks.

Next, we test for the possibility that savings banks either reduce or grant more municipality or state loans after their reform-induced mergers. A reduction of lending to the local municipality or the host state of government-owned banks would support concerns that the statuary obligation of savings banks to serve their local community might be undermined. Expanding local government lending, in turn, could give rise to entrenchment concerns

TABLE 3.10: Reform effects on deposits and credit provision of merging banks.

		Public Loans		Private Sector Loans					
	L(Deposits)	L(Municipal)	L(State)	L(Consumer)	L(Comm)	L(Industrial)	L(Agri)	L(Real estate)	L(Loans)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Merger	0.001	-0.000	-0.000	0.007***	0.011***	0.004***	0.002***	0.004*	0.003*
	(0.001)	(0.000)	(0.000)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Reform	-0.001	0.010	0.002	-0.011	-0.007	0.008	0.008	-0.003	-0.010
	(0.006)	(0.008)	(0.010)	(0.014)	(0.025)	(0.005)	(0.006)	(0.009)	(0.013)
Merger*Reform	-0.003	-0.004	0.001	0.003	0.015	-0.009*	-0.006	-0.001	0.019
	(0.009)	(0.008)	(0.009)	(0.015)	(0.017)	(0.005)	(0.006)	(0.011)	(0.012)
Merger*SB	0.013***	0.005***	-0.001	0.014***	0.009	0.004**	-0.001	-0.005	0.014***
	(0.004)	(0.002)	(0.001)	(0.004)	(0.006)	(0.002)	(0.002)	(0.005)	(0.005)
Reform*SB	0.032**	-0.024	0.018	0.038**	0.016	-0.023***	-0.007	0.002	-0.039**
	(0.016)	(0.017)	(0.014)	(0.019)	(0.025)	(0.008)	(0.010)	(0.014)	(0.018)
Merger*Reform*SB	-0.005	0.009	0.006	-0.005	0.012	0.018***	0.009	0.012	-0.028*
	(0.012)	(0.011)	(0.010)	(0.015)	(0.024)	(0.007)	(0.007)	(0.016)	(0.015)
Observations	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788	788	788	788	788
Mean	0.74	0.02	0	0.13	0.23	0.06	0.04	0.12	0.59
Median	0.75	0.01	0	0.12	0.22	0.05	0.02	0.11	0.61
Standard Deviation	0.08	0.03	0.01	0.07	0.09	0.03	0.04	0.09	0.1
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.331	0.347	0.181	0.469	0.546	0.550	0.455	0.599	0.333

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Lagged covariates are L(GDP) at the county-level, Equity, LLP, CIR, Liquidity, and Size at the bank-level. In Column (5) RoA and NII are added as control variables. Dependent variables are: *L(Deposit)* which is the logarithm of deposits to costumers;*L(Loans)*, the logarithm of total loans to non-bank customers; *L(Consumer)*, the logarithm of loans to private households (excl. real estate); *L(Comm)*, the logarithm of loans to firms and private businesses (excl. the industrial and agricultural sector); *L(Industrial)*, the logarithm of loans to firms in the industrial sector; *L(Agri)*, the logarithm of loans to firms in the agricultural sector; *L(Real Estate)*, the logarithm of loans to private households for the purpose of real estate; *L(Municipal)*, the logarithm of loans to the public sector on the municipal-level *L(State)*, the logarithm of loans to the public sector on the state-level.

between local politicians and bankers. Both outcomes would indicate some economic costs that would juxtapose the benefits from enhanced bank profitability after reform-induced mergers. The empirical evidence, however, bears no indication for such concerns. The triple interaction term for both forms of government lending (Columns (2) and (3)) are not significant. As such, the absence of a significant differential effect bodes well.

A third potential concern regarding undesirable real effect could be an overall credit restriction to local business or at a politically motivated allocation to potentially less productive sectors of the economy. Columns (4) through (8) therefore specify loans to different sectors as well as total private sector lending in Column (9). The only category that exhibits a significant effect is industrial loans (Column (6)), i.e., loans to firms in the industrial sector. The triple interaction coefficient is positive and highly significant. Savings banks that experienced a reform-induced merger increase their industrial loans by around 2% in comparison to cooperative banks. In contrast, the merged cooperative banks reduced their lending in this category by around 0.9% compared to the time before the reform which leads to a gross increase of 0.9% in industrial lending by savings banks after reform-induced mergers. Thereby, our results suggest a positive spillover effect of county reforms on the real sector in the form that savings banks use the improvements in their profitability to encourage firm lending after they have been merged after the reforms.

3.5.2 Non-financial firm responses

To further zoom into such positive externalities of reform-induced mergers to the real economy, we mobilize detailed firm-level data of corporations connected to savings banks. Specifically, we use detailed balance sheet and profit and loss data for firms that held a credit relation with a savings bank between 1995 and 2006. These data have been used before (Puri et al., 2011; Gropp et al., 2013; Behr et al., 2013; Inklaar et al., 2015) and feature an important link between savings banks and firms: the share of loans provided by savings banks (relative to total loans) SB. In comparison to the other studies we restrict our data in two dimensions. First, we only use regions in Eastern Germany because these were subject to county reforms between 1995 and 2006. Second, we delete all firms with missing information for the main variables, which leads to a sample of 51,792 observations for 18,664 firms. With these data at hand, we estimate:

$$Outcome_{j,t} = \alpha_j + \gamma_{r,t} + \alpha_1\ (SB_{j,t}) + \alpha_2\ (RM_{i,r,t-h} \times SB_{j,t}) + \epsilon_{j,t} \quad (3.2)$$

Equation (3.2) measures the impact of a reform-induced merger of a savings banks RM in region r on firm j conditional on the share of savings bank loans SB that a firms holds in year t. RM is an indicator variable equal to one in the year when a savings bank in a firm's region merges due to a reform. We specify different post-merger spells that are indicated by the subscript h.

We specify four outcome variables to assess the real effects of reform-induced bank mergers: firms' external financing cost measured as total interest expense over total liabilities; the natural logarithm of firms' gross real investments; the natural logarithm of firms' number of employees; and firms' leverage ratio measured as total liabilities over total assets. We use firm fixed effects α_j and region-year fixed effects $\gamma_{r,t}$ to control for constant factors on the firm level and for regional effects that vary over time. The coefficient of interest is α_2. It gauges the differential effects on the outcome variables for firms located in regions that exhibit a reform-induced savings bank merger in a given year with respect to the closeness of the firm's credit relation to this savings bank. We present our results in Figure 3.4. The associated (detailed) regression results and descriptive statistics for all variables are shown in Table 3.21 in the Appendix.

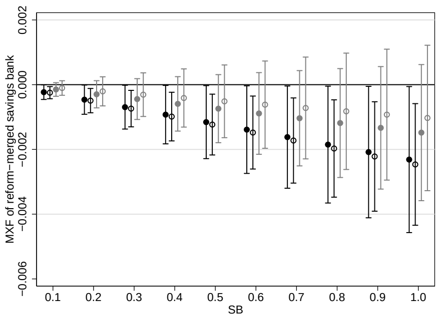
Each graph in Figure 3.4 shows the marginal effect of $SB \times RM$ from Equation (3.2) for realizations of SB between 0.1 to 1. For each value of SB we provide the marginal effect pertaining to four different post-merger spells: (i) the contemporaneous year (solid black dot); (ii) the contemporaneous and the subsequent year (black circle); (iii) the contemporaneous and subsequent two years (solid gray dot); and (iv) the contemporaneous and subsequent three years (gray circle). For each estimate we also provide the 95% confidence interval.

The upper left graph shows the marginal effects of reform-induced savings bank mergers on the external financing costs of firms. Across the entire distribution of values for SB, we estimate a negative and significant marginal effect for the two specifications of short-term effects, i.e. up to the first subsequent post-merger year. This effect ranges between 10 and 25 basis points, which resembles a contraction of around 5.5% compared to the average external funding cost in the sample of 4.6 percentage points. The marginal effects turn insignificant for spells up and until the second and third year after reform-induced mergers. We further find that the reduction of external financing cost is larger for those firms that borrow larger loan shares from savings banks. As such, these results provide strong evidence against concerns that the exit of local banks after the elimination of governance frictions embodied in government ownership impose tighter credit conditions especially on those SMEs that are very dependent on local government-owned banks. Importantly, this result does not necessarily contradict Berger et al. (1998), Degryse et al. (2011) or Berger et al. (2017), who emphasize the importance of small, local lenders to provide credit and liquidity insurance to SMEs. Instead, our result provide important indications that government-owned local lenders that are shielded from market forces incur unrealized profitability potential, which in turn also benefit SMEs when released after the elimination of political frictions.

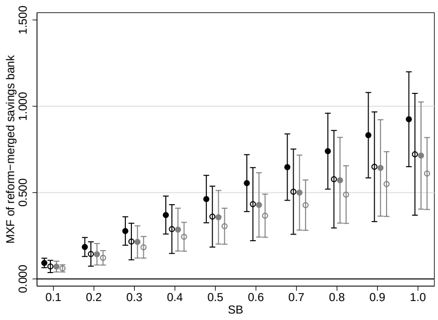
The upper right graph reveals that corporations that are more intensive users of savings bank loans invest significantly more after a reform-induced merger of government-owned banks in the firm's region. This effect is long-lived, exhibiting a significantly positive response during the entire three year spell after the merger. In economic terms, firms that borrow 50% of their loans from a savings bank increase their investments by around 50% in the years after a reform-induced merger. Thus, this result corroborates the notion that county reforms unleash potential in the local financial sector that was held back by additional frictions associated with fragmented local governments' interests of many counties. Taken together, the results indicate that post-reform merged savings banks lend more to industry customers at lower cost of credit, which is channeled by these corporations into additional investment into fixed assets.

FIGURE 3.4: Real effects of reform-induced savings bank mergers.

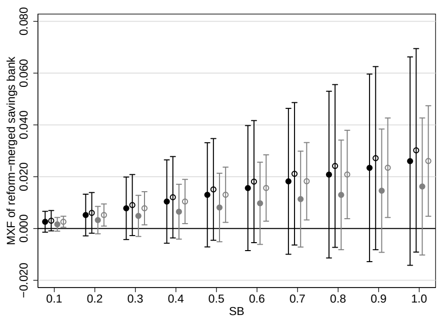
(A) External financing cost



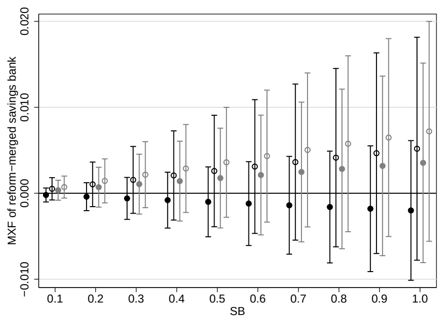
(B) Investment



(C) Employment



(D) Leverage



Notes: The graphs depict the marginal effects of a reform-induced savings bank merger (in a region) on firm outcomes (of firms in that region) conditional on the firms' share of savings banks' loans to total loans. The dots represents the marginal effects and the solid line the 95% confidence interval. We show the effects for shares of savings banks' loans between 0.1 and 1. For each level we show four marginal effects: first, the marginal effect from the contemporaneous year (solid black dot); second, the marginal effect from the contemporaneous and the subsequent year (black, unfilled dot); third, the marginal effect from the contemporaneous and the subsequent two years (solid gray dot); fourth, the marginal effect from the contemporaneous and the subsequent three years (gray, unfilled dot). We calculate the effects from regressions of Equation (3.2) and provide detailed results in Table 3.21.

In tango, the first two graphs of Figure 3.4 show that savings bank mergers due to a reform are beneficial for connected firms. Reform-induced consolidation seems to release resources that fuel corporate investment. Significant differential effects thus indicate that the elimination of political barriers to bank exit in Germany also sparked meaningful real economic spillovers.

The lower left graph of Figure 3.4 signals mildly positive employment effects in the range of 1% to 2% for the period three years after the mergers. Longer adjustment responses are commensurate with the notion of labor market frictions that are more binding compared to physical capital markets, for example because of more restrictive labor laws that limit the ability of corporates to adjust wages downward or to lay-off staff in economic downturns. The lower right graph finally shows that these real expansionary effects are at the same time not associated with any significant effects on firms' leverage ratios.

In sum, the factor market for physical capital – and with some delay also labor markets – respond significantly positive to improved local financial market development whereas we find no support for concerns of larger banks fueling an over-indebtedness of local firms. Thus, reforms that force government-owned savings banks into mergers appear to be beneficial because connected firms can increase investments and employment due to lower financing costs. At the same time, these real expansionary effects do not increase corporate leverage ratios in the years after the mergers.

3.6 Conclusion

This paper sheds light on the question if and to what extent the existence of political barriers in the form of government ownership is (i) a hindrance to consolidation (ii) and thus an obstacle to sustainable profitability in the banking industry. We conjecture that due to the absence of a (sufficiently) complete market for corporate control, too few bank exits occur. The absence of efficient attrition, in turn, fuels excess capacities that are partly responsible for observed profitability sclerosis after the Great Financial Crisis especially in European banking markets.

To identify any causal effect of government ownership on subdued exits, which in turn might or might not hold back profitability, is a daunting task that faces a battery of serious econometric challenges. First of all, if government ownership impedes "natural" governance mechanisms, we aim to unveil a non-event, namely those bank exits that should have, but did not happen. Second, and somewhat more mundane and well-known, it is unclear whether banks do merge because of poor performance or whether mergers induce differential performance. And third, a number of additional unobservable factors might drive profitability that have little to nothing to do with post-merger performance, ranging from aggregate demand, to credit market frictions, on to political and regulatory differences across regimes in, say, different countries.

Our setting is unique as it exploits a number of features that take care of these challenges. We consider local savings and cooperative bank mergers in Germany since 1993 until 2015. Our identification rests on three decisive features in German banking. First, local savings banks are owned by their regional political entity, usually one of the 402 counties that existed in 2015. Second, whenever these political entities are combined, residing savings banks are forced to merge as well because each county must not own more than one savings bank. In total, 10 spatial reforms occurred since the re-unification of Germany, thereby leading to numerous "forced" savings banks mergers. We compare these reform-induced mergers to transactions amongst cooperative banks – which are privately owned and thus not subject to government-ownership shelter regarding corporate governance – in both reformed and non-reformed counties. We also compare forced to voluntary savings bank mergers that happened without county reforms inducing them. Third, these county reforms are decided upon at the federal level in the parliaments of each of the 16 states. As such, they represent truly exogenous governance shocks to local savings banks that are required by law to merge. If the pre-merger entities were therefore inefficient and unprofitable because of shelter from governance forces by "their" local political owners, a merger of counties should unleash profitability potential after forced merger took place.

Based on comprehensive data obtained from Deutsche Bundesbank, we confirm indeed that savings bank profitability increased substantially relative to that of cooperative banks in both reformed and non-reformed counties. For up to eight years after mergers that were induced by county reforms, return on equity increased by approximately 5 to 6 percentage points, which is substantial in light of mean profitability on the order of 8 percentage points. These improvements, however, appear to be associated with increasing risk indicators. Merging savings banks reduced their capitalization as well as loan loss provisioning. Likewise, we find evidence of increasing non-performing loan shares after such county-reform induced mergers. Market power concerns are in turn not confirmed. If anything, banks refinancing expenses are reduced which might in fact indicate improvements in managerial efficiency. However, other indicators of operational efficiency – such as employment or the number of branches – do not exhibit recognizable declines.

Based on detailed non-financial firm data of savings bank customers, we further show that affected savings banks increase their lending to corporates. Small and medium sized enterprises connected to reform-induced merged banks exhibit in addition lower external financing costs. We also document important real responses by these corporations in terms of higher real investments and employment in the aftermath of reform-induced mergers by savings banks.

Overall, our results thus indicate that performance improvements unleashed by reducing government ownership barriers to market exit in banking is realized at the expense of increased risk at the average bank. Whether these effects are simply a reversal of inefficiently low risk-taking prior to enforced banking market consolidation or if it indicates excessive risk taking cannot be concluded on grounds of our partial equilibrium, empirical exercise. However, the robust as well as statistically and economically significant investment and employment responses strongly suggest that (political) reform-induced banking market consolidation generated positive spillovers to the real economy without any significant welfare cost like credit crunches or constrained provision of financial services. Thus, our results might be informative to policymakers how to deal with continuously low profitability in European banking which exhibits increasingly more direct and indirect interdependence between banks and national government since the Great Financial and the sovereign debt crises.

Appendix B

Table 3.11: Overview of county-reforms.

Date	pre-year post-year	Dead-line		Counties N	Counties Δ	Savings N	Savings Δ	Cooperatives N	Cooperatives Δ
Brandenburg									
12/06/1993	1992	2	*pre*	44	-59%	30	-30%	36	-14%
	1995		*post*	18		21		31	
Mecklenburg-Vorpommern									
06/12/1994	1993	3	*pre*	37	-51%	26	-38%	32	-19%
	1997		*post*	18		16		26	
Saxony-Anhalt									
07/01/1994	1993	3	*pre*	40	-40%	36	-31%	41	-20%
	1997		*post*	24		25		33	
Thuringia									
07/01/1994	1993	-	*pre*	40	-45%	33	-45%	50	-18%
	1996		*post*	22		18		41	
Saxony									
08/01/1994,	1993	2-3	*pre*	54	-46%	45	-47%	53	-15%
06/16/1996	1997		*post*	29		24		45	
Saxony-Anhalt									
07/01/2007	2006	2	*pre*	24	-42%	22	-32%	17	0%
	2009		*post*	14		15		17	
Saxony									
08/01/2008	2007	-	*pre*	29	-55%	15	0%	25	-4%
	2010		*post*	13		15		24	
Mecklenburg-Vorpommern									
09/04/2011	2010	-	*pre*	18	-56%	10	0%	11	0%
	2013		*post*	8		10		11	

Notes: This table shows an overview of county-reforms since German reunification with the number of counties, savings and cooperative banks before and after the reform. Date refers to the date of enactment. The numbers of counties are presented before and after this date. Deadline states whether there was a deadline in years. Pre-year is the last year before a reform and post-year marks the year after the deadline expired or – if no deadline was given – two years after the reform. The numbers of banks are counted in these years. The reduction of counties and banks between respective pre- and post-years is given in percentage. In Saxony, most counties were reformed on 1st of August 1994. Law suits were filed which made three amendments to the original reform bill, the last of which on 16th of June 1996. The ordinary deadline in Saxony was two years but banks located in counties involved in the law suits were exempted.

Table 3.12: Placebo-treatments for the effect on RoE.

Rejection rate at 1%	at 5%	at 10%
0.013	0.069	0.114

Notes: This table shows average rejection rates for 1,000 repetitions of placebo-treatments over the cross-section and time. Each repetition where *Reform* was randomly assigned on other mergers among all mergers including the actually treated tests $H_0 : \beta_6 = 0$ using the baseline specification.

TABLE 3.13: Robustness checks for the effect on RoE.

	Baseline (1)	Baseline RoNE (2)	Baseline RoA (3)	90s (4)	00s (5)	Excl. Distress (6)	Excl. Ties (7)	Cont. Counties (8)	Collapse Time Dim. (9)
SB									-0.015
									(0.009)
Merger	-0.003*	-0.004*	-0.000	-0.002	-0.004*	-0.002	-0.005**	-0.010**	-0.020**
	(0.001)	(0.002)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.009)
Reform	0.007	0.014	0.000	-0.003	0.003	0.002	0.002	0.004	
	(0.007)	(0.010)	(0.000)	(0.019)	(0.010)	(0.011)	(0.010)	(0.015)	
Merger*Reform	-0.016**	-0.028**	-0.001	-0.007	-0.006	-0.005	-0.012	-0.017	
	(0.008)	(0.013)	(0.000)	(0.017)	(0.013)	(0.010)	(0.010)	(0.021)	
Merger*SB	-0.014***	-0.021***	-0.001***	-0.013	-0.010**	-0.021***	-0.012**	-0.031	0.032***
	(0.004)	(0.006)	(0.000)	(0.009)	(0.005)	(0.004)	(0.005)	(0.026)	(0.011)
Reform*SB	-0.008	-0.035*	-0.001**	0.001	-0.052***	-0.002	-0.006		
	(0.012)	(0.020)	(0.001)	(0.030)	(0.010)	(0.017)	(0.029)		
Merger*Reform*SB	0.056***	0.103***	0.003***	0.060***	-0.011	0.046***	0.078***	0.076**	
	(0.013)	(0.022)	(0.001)	(0.021)	(0.013)	(0.017)	(0.017)	(0.036)	
Observations	7,300	7,300	7,300	2,513	4,787	4,220	5,428	485	310
Banks	788	788	788	632	724	501	591	63	67
Govern. Banks	163	163	163	124	128	123	121	19	43
Mutual Banks	625	625	625	508	596	378	470	44	24
Treated Deals	74	74	74	60	20	44	46	20	74
Non-treated Deals	1,553	1,553	1,553	801	1,162	800	1,173	90	0
Mean	0.078	0.11	0.006	0.089	0.067	0.085	0.08	0.062	0.061
Median	0.078	0.11	0.006	0.093	0.065	0.085	0.079	0.065	0.061
Standard Deviation	0.062	0.089	0.005	0.059	0.063	0.056	0.064	0.072	0.047
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank & Year*State FE	yes	yes	yes	yes	yes	yes	yes	no	no
R-squared (within/[overall])	0.324	0.326	0.326	0.354	0.260	0.403	0.328	0.467	[0.039]

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Column (1) reproduces the baseline results. Column (2) specifies *Net Equity* instead of *Gross Equity* as the dependent variable. *Net Eq* is nominal equity plus retained earnings. In column (3) the dependent variable is return on gross total assets. In Column (4) the sample period is 1994 to 2000. In column (5) the sample period is 2001 to 2015. In Column (6) all banks that once reported a distress event are excluded. In Column (7) all banks with a ratio of loans to municipalities to total loans above their banking groups' average ratio are excluded. In Column (8) only banks on the boarders between reformed and non-reformed states are included. Fixed effects for each neighboring county-pair are added. In Column (9) the residuals of a regression of RoE on Reform-Treatment, Year*State fixed effects, and the main covariates are regressed on the post-dummy for treated deals only, following Bertrand et al. (2004). Controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, and Size at the bank-level, and L(GDP) at the county-level.

TABLE 3.14: Effects on gross equity and its components.

		Net Equity			Accruals				Other Equity		
	L(Gross Eq)	L(Nom Eq)	L(Retained E)	L(Other R)	L(Current R)	L(A Pension)	L(A Taxes)	L(A Risk)	L(Special Items)	L(Subordinated)	L(Participate)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Merger	-0.014***	0.002	-0.170	-0.012**	-0.008	0.017	-0.581***	-0.035***	0.005	-0.396***	-0.011
	(0.004)	(0.032)	(0.114)	(0.005)	(0.017)	(0.038)	(0.118)	(0.011)	(0.174)	(0.151)	(0.150)
Reform	0.045	0.708	-0.926	0.002	-0.394	-1.665	0.246	0.009	-1.139	0.425	1.188
	(0.040)	(0.694)	(1.134)	(0.036)	(0.338)	(1.698)	(0.577)	(0.136)	(0.713)	(2.342)	(2.259)
Merger*Reform	0.045	-0.316	0.600	0.047	0.344	1.436	-0.383	0.044	1.836***	0.362	-0.250
	(0.042)	(0.502)	(0.848)	(0.033)	(0.278)	(1.371)	(0.576)	(0.104)	(0.680)	(2.062)	(1.789)
Merger*SB	-0.021*	0.065	-0.158	-0.096***	-0.160	-0.104*	0.218	0.264***	-1.360***	1.720***	0.838*
	(0.013)	(0.371)	(0.284)	(0.032)	(0.102)	(0.057)	(0.315)	(0.030)	(0.423)	(0.249)	(0.458)
Reform*SB	-0.250***	-1.341	3.440**	-0.093	0.575	1.527	-0.536	-0.174	0.024	-1.381	-4.569**
	(0.069)	(1.085)	(1.333)	(0.067)	(0.550)	(1.298)	(0.637)	(0.198)	(1.378)	(2.038)	(2.201)
Merger*Reform*SB	-0.007	-0.193	0.288	0.037	-0.244	-1.399	1.423**	-0.368**	0.519	-2.660	-0.650
	(0.057)	(0.715)	(0.972)	(0.051)	(0.607)	(1.247)	(0.640)	(0.145)	(0.954)	(1.818)	(1.823)
Observations	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788	788	788	788	788	788	788
Mean	17.66	13.79	1.67	16.93	13.86	14.2	11.84	14.79	5.12	10.92	7.38
Median	17.56	15.54	0.00	16.82	13.84	14.73	12.7	14.77	0.00	14.37	10.24
Standard Deviation	1.15	5.25	4.48	1.19	1.32	3.02	3.65	1.13	6.2	7.06	7.37
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.816	0.147	0.281	0.728	0.084	0.193	0.177	0.445	0.415	0.280	0.356

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variables are logarithms and defined as: *Nom Eq* is nominal equity. *Retained E* are retained earnings. *Other R* are other retained earnings. *Current R* are retained earnings from the current accounting period. *A Pensions* are accruals for pensions. *A Taxes* are accruals for taxes. *A Risk* are other accruals including those formed by loan loss provisions. *Subordinated* is subordinated debt. *Participate* are debt obligations that participate in profits. *Special Items* are special items due to currency conversion and the fonds for banking risk. Bank controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, size, and L(GDP).

TABLE 3.15: Effects on revenue and its components.

	L(Total Rev)	Operating Revenue					Non-operating Revenue	
		L(Int Rev)	L(Com Rev)	L(Fin Rev)	L(Other Rev)	L(Curr Rev)	L(Appr Rev)	L(Exord Rev)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Merger	-0.007**	-0.008**	0.004	-0.360***	0.020	0.019	-1.016***	-0.314**
	(0.004)	(0.003)	(0.004)	(0.125)	(0.021)	(0.024)	(0.174)	(0.143)
Reform	0.022	0.023	0.011	1.098	-0.035	0.067	-0.822	-2.322
	(0.032)	(0.032)	(0.027)	(1.226)	(0.125)	(0.439)	(1.451)	(1.988)
Merger*Reform	0.043	0.065**	0.003	0.623	-0.066	-0.448	1.986	2.355
	(0.030)	(0.032)	(0.027)	(1.402)	(0.162)	(0.444)	(1.459)	(2.204)
Merger*SB	-0.032***	-0.007	-0.023**	0.182	-0.162***	-0.164***	-1.371***	-0.124
	(0.008)	(0.008)	(0.009)	(0.292)	(0.040)	(0.056)	(0.528)	(0.294)
Reform*SB	-0.094**	-0.092**	-0.013	-3.846**	0.027	0.090	-0.285	1.701
	(0.038)	(0.038)	(0.038)	(1.538)	(0.156)	(0.621)	(1.782)	(1.996)
Merger*Reform*SB	-0.027	-0.050	-0.010	-0.093	0.011	0.087	-0.824	-1.672
	(0.038)	(0.039)	(0.037)	(1.519)	(0.184)	(0.498)	(1.874)	(2.122)
Observations	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788	788	788	788
Mean	17.57	17.38	15.25	7.79	13.41	13.24	8.89	1.99
Median	17.49	17.3	15.27	9.89	13.39	13.1	11.45	0.00
Standard Deviation	1.08	1.07	1.14	5.25	1.41	1.87	5.82	4.69
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.420	0.629	0.800	0.472	0.324	0.414	0.297	0.266

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variables are logarithms and defined as: *Int Rev* are revenues earned on interest bearing assets. *Com Rev* are revenues earned on commissions and fees. *Fin Rev* are revenues earned on the trading book. *Other Rev* are other operating revenues. *Curr Rev* are current revenues. *Appr Rev* are revenues earned on appreciations. *Exord Rev* are extraordinary revenues. Bank controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, size, and L(GDP).

Table 3.16: Effects on total costs and its components.

	L(Total Cost)	Operating Costs					Non-operating Costs	
		L(Int Cost)	L(Com Cost)	L(Fin Cost)	L(Other Cost)	L(Admin Cost)	L(Depr Cost)	L(Exord Cost)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Merger	-0.005	-0.015***	0.001	-0.315**	0.005	-0.006*	-0.163**	0.070
	(0.004)	(0.005)	(0.009)	(0.144)	(0.027)	(0.003)	(0.066)	(0.127)
Reform	0.017	0.019	0.192***	0.825	-0.251*	0.032	-0.042	0.234
	(0.031)	(0.037)	(0.072)	(1.190)	(0.152)	(0.026)	(0.417)	(1.365)
Merger*Reform	0.049	0.114**	-0.035	0.758	0.293	-0.041	-0.508	0.454
	(0.030)	(0.046)	(0.075)	(1.202)	(0.180)	(0.027)	(0.796)	(1.829)
Merger*SB	-0.014	0.027**	0.015	-0.297	0.048	-0.012*	0.264**	-0.453
	(0.009)	(0.011)	(0.034)	(0.333)	(0.050)	(0.007)	(0.110)	(0.347)
Reform*SB	-0.071*	-0.147***	-0.238**	-3.523***	0.174	-0.003	0.099	0.567
	(0.039)	(0.053)	(0.095)	(1.222)	(0.182)	(0.031)	(0.525)	(1.526)
Merger*Reform*SB	-0.077**	-0.134**	0.046	-0.469	-0.449**	0.027	0.366	-0.644
	(0.038)	(0.055)	(0.113)	(1.256)	(0.200)	(0.035)	(0.835)	(1.898)
Observations	7,300	7,300	7,300	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788	788	788	788
Mean	17.48	16.72	12.64	2.77	12.46	16.58	14.57	1.66
Median	17.39	16.62	12.66	0.00	12.45	16.52	14.7	0.00
Standard Deviation	1.08	1.14	1.13	4.79	1.78	1.02	2.02	4.22
Bank & County Controls	yes	yes	yes	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.549	0.831	0.677	0.239	0.300	0.456	0.247	0.283

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variables are logarithms and defined as: *Int Cost* are costs paid on interest bearing assets. *Com Cost* are costs paid on commissions and fees. *Fin Cost* are costs paid on the trading book. *Other Cost* are other operating costs. *Admin Cost* are administrative costs. *Depr Cost* are costs paid on depreciations. *Exord Cost* are extraordinary costs. Bank controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, size, and L(GDP).

TABLE 3.17: Effects on net interest margins.

	NIM	L(IBA)	Interest Bearing Assets		
			L(Interbank)	L(Costumer)	L(Bonds & Sec)
	(1)	(2)	(3)	(4)	(5)
Merger	0.000***	-0.013***	-0.008**	-0.015***	-0.100***
	(0.000)	(0.003)	(0.003)	(0.005)	(0.015)
Reform	-0.001	0.039	0.023	0.019	-0.057
	(0.001)	(0.030)	(0.032)	(0.037)	(0.128)
Merger*Reform	-0.001	0.057*	0.065**	0.114**	0.125
	(0.001)	(0.033)	(0.032)	(0.046)	(0.111)
Merger*SB	-0.000**	0.003	-0.007	0.027**	0.087
	(0.000)	(0.008)	(0.008)	(0.011)	(0.068)
Reform*SB	0.002**	-0.109***	-0.092**	-0.147***	0.023
	(0.001)	(0.038)	(0.038)	(0.053)	(0.164)
Merger*Reform*SB	0.003***	-0.096**	-0.050	-0.134**	-0.393***
	(0.001)	(0.039)	(0.039)	(0.055)	(0.140)
Observations	7,300	7,300	7,300	7,300	7,300
Banks	788	788	788	788	788
Mean	0.03	20.21	17.38	16.72	18.04
Median	0.03	20.13	17.3	16.62	18.0
Standard Deviation	0.01	1.1	1.07	1.14	1.15
Bank & County Controls	yes	yes	yes	yes	yes
Bank, Year-State FE	yes	yes	yes	yes	yes
R-squared (within)	0.693	0.594	0.629	0.831	0.194

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Dependent variables are logarithms and defined as: *IBA* are interest bearing assets, consisting of *Interbank*, *Customer*, and *Bonds & Sec*. *Interbank* are total loans to credit institutions. *Customer* are total loans to customers. *Bonds & Sec* are total of bonds and securities. Bank controls are lagged by one year and comprise LLP, CIR, Liquidity, Loans, NII, size, and L(GDP).

TABLE 3.18: Summary statistics of dependent variables by treatment and ownership status.

	Savings			Cooperatives			Diff.	Diff.	Diff.
Levels	Non-T	Treat	Diff.	Non-T	Treat	Diff.	Non-T	T	Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Levels									
Equity Decomposition									
L(Gross Eq)	19.166	18.585	0.581	17.347	17.352	-0.005	1.820	1.233	-0.586
	0.771	0.823	0.000	0.961	0.968	0.980	0.000	0.000	0.016
L(Net Eq)	18.665	18.038	0.628	17.037	17.029	0.008	1.629	1.009	-0.620
	0.780	0.743	0.000	0.912	0.978	0.972	0.000	0.000	0.010
L(Accruals)	17.036	16.248	0.789	15.292	15.432	-0.141	1.744	0.815	-0.929
	0.757	0.920	0.000	1.106	0.983	0.532	0.000	0.003	0.000
L(Other Eq)	17.387	17.287	0.100	13.762	11.529	2.233	3.625	5.758	2.133
	2.283	1.236	0.619	4.468	6.891	0.164	0.000	0.001	0.160
Profit Decomposition									
L(Profit)	15.941	13.503	2.437	13.952	13.873	0.079	1.989	-0.369	-2.358
	2.967	5.819	0.004	3.566	3.514	0.921	0.000	0.743	0.034
L(Total Rev)	19.021	18.514	0.507	17.265	17.333	-0.067	1.756	1.181	-0.575
	0.760	0.603	0.000	0.887	0.908	0.745	0.000	0.000	0.008
L(Op Rev)	19.006	18.507	0.499	17.247	17.305	-0.059	1.759	1.201	-0.558
	0.758	0.599	0.000	0.885	0.906	0.776	0.000	0.000	0.010
L(Non-Op Rev)	11.072	8.377	2.694	9.256	10.251	-0.995	1.816	-1.874	-3.689
	6.015	6.530	0.006	5.578	5.707	0.447	0.000	0.237	0.018
L(Total Cost)	18.931	18.431	0.500	17.170	17.246	-0.076	1.761	1.184	-0.577
	0.761	0.608	0.000	0.880	0.886	0.705	0.000	0.000	0.007
L(Op Cost)	18.829	18.262	0.566	17.087	17.121	-0.034	1.741	1.141	-0.600
	0.759	0.627	0.000	0.875	0.895	0.867	0.000	0.000	0.006
L(Non-Op Cost)	16.423	16.445	-0.022	14.221	14.891	-0.670	2.202	1.554	-0.648
	0.990	0.713	0.839	1.898	1.209	0.024	0.000	0.000	0.024
Risk Channel									
L(zscore)	3.217	3.165	0.053	3.364	3.652	-0.288	-0.147	-0.488	-0.341
	0.655	0.453	0.517	0.638	0.969	0.269	0.000	0.080	0.182
SD(RoA)	0.002	0.002	0.000	0.002	0.002	0.000	0.000	-0.000	-0.000
	0.002	0.001	0.400	0.002	0.002	0.920	0.651	0.935	0.877
Tier1	0.044	0.038	0.005	0.050	0.045	0.005	-0.006	-0.006	-0.001
	0.010	0.011	0.001	0.012	0.010	0.043	0.000	0.020	0.802
LLP	0.009	0.024	-0.016	0.007	0.010	-0.003	0.001	0.014	0.013
	0.007	0.014	0.000	0.009	0.007	0.070	0.000	0.000	0.000
NPL	0.063	0.100	-0.037	0.061	0.097	-0.036	0.002	0.002	0.000
	0.039	0.045	0.000	0.046	0.073	0.088	0.452	0.911	0.981
Efficiency Channel									
Branch	0.213	0.305	-0.092	0.480	0.656	-0.176	-0.268	-0.352	-0.084
	0.113	0.117	0.000	0.273	0.343	0.033	0.000	0.000	0.273
Empl	0.252	0.304	-0.052	0.305	0.359	-0.053	-0.053	-0.055	-0.002
	0.047	0.088	0.000	0.083	0.097	0.023	0.000	0.035	0.950
Empl/Branch	22.665	10.641	12.024	8.093	6.394	1.699	14.572	4.247	-10.325
	44.738	3.148	0.000	4.424	2.111	0.002	0.000	0.000	0.000
Wages/Empl	0.017	0.020	-0.003	0.128	0.087	0.041	-0.111	-0.067	0.043
	0.014	0.010	0.103	0.130	0.063	0.011	0.000	0.000	0.002
CIR	0.669	0.630	0.039	0.739	0.737	0.002	-0.070	-0.107	-0.037
	0.068	0.068	0.000	0.139	0.080	0.900	0.000	0.000	0.067
Market Power Channel									
NIM	0.024	0.031	-0.006	0.029	0.031	-0.002	-0.005	-0.000	0.005
	0.004	0.009	0.000	0.005	0.006	0.251	0.000	0.997	0.010
Int earned	0.060	0.061	-0.001	0.061	0.059	0.002	-0.001	0.002	0.003
	0.009	0.015	0.767	0.011	0.015	0.567	0.267	0.603	0.507
Int paid	0.036	0.030	0.006	0.032	0.028	0.004	0.004	0.002	-0.002
	0.007	0.009	0.000	0.009	0.010	0.136	0.000	0.440	0.407
L(IBA)	21.651	21.121	0.530	19.903	19.882	0.021	1.748	1.239	-0.509
	0.776	0.646	0.000	0.906	0.903	0.918	0.000	0.000	0.020
Market share	0.442	0.481	-0.039	0.081	0.091	-0.010	0.360	0.390	0.029
	0.210	0.210	0.202	0.061	0.044	0.327	0.000	0.000	0.354

continued.

	Savings			Cooperatives			Diff.	Diff.	Diff.
	Non-T	Treat	Diff.	Non-T	Treat	Diff.	Non-T	T	Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
First-Differences									
Equity Decomposition									
L(Gross Eq)	0.056	0.092	-0.036	0.060	0.071	-0.011	-0.004	0.021	0.025
	0.071	0.113	0.028	0.058	0.087	0.592	0.230	0.406	0.310
L(Net Eq)	0.050	0.035	0.016	0.056	0.054	0.002	-0.006	-0.019	-0.014
	0.056	0.029	0.001	0.042	0.047	0.842	0.034	0.096	0.230
L(Accruals)	0.044	0.107	-0.063	0.044	0.057	-0.013	-0.000	0.050	0.050
	0.151	0.370	0.227	0.195	0.239	0.814	0.985	0.503	0.494
L(Other Eq)	0.068	1.406	-1.338	0.230	0.030	0.199	-0.162	1.375	1.537
	1.588	3.859	0.015	2.374	0.415	0.067	0.067	0.013	0.004
Equity Decomposition									
L(Profit)	-0.350	-1.423	1.073	-0.007	0.148	-0.154	-0.344	-1.570	-1.227
	2.970	6.879	0.266	3.081	0.638	0.332	0.024	0.106	0.201
L(Total Rev)	0.012	0.011	0.001	0.002	0.027	-0.025	0.010	-0.016	-0.025
	0.073	0.060	0.946	0.078	0.093	0.248	0.010	0.489	0.251
L(Op Rev)	0.008	0.013	-0.005	-0.000	0.017	-0.018	0.009	-0.004	-0.013
	0.062	0.055	0.577	0.043	0.057	0.181	0.004	0.767	0.376
L(Non-Op Rev)	0.609	-0.716	1.325	0.027	0.749	-0.722	0.583	-1.465	-2.047
	6.451	6.956	0.190	6.628	7.674	0.679	0.077	0.461	0.294
L(total Cost)	0.017	0.015	0.002	-0.000	0.013	-0.013	0.017	0.002	-0.015
	0.086	0.084	0.876	0.079	0.104	0.575	0.000	0.934	0.555
L(Op Cost)	0.011	-0.012	0.023	-0.001	-0.006	0.005	0.012	-0.007	-0.019
	0.073	0.076	0.038	0.060	0.061	0.744	0.001	0.707	0.281
L(Non-Op Cost)	0.088	0.242	-0.154	-0.026	0.153	-0.179	0.114	0.089	-0.025
	0.672	0.787	0.175	1.859	1.356	0.564	0.021	0.785	0.937
Risk Channel									
L(zscore)	-0.058	-0.041	-0.018	-0.003	-0.066	0.063	-0.055	0.026	0.081
	0.430	0.458	0.832	0.466	0.414	0.580	0.018	0.852	0.550
SD(RoA)	0.000	0.000	-0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.001	0.001	0.718	0.001	0.001	0.753	0.079	0.344	0.621
Tier1	0.001	0.002	-0.001	0.002	0.001	0.001	-0.001	0.002	0.002
	0.003	0.003	0.003	0.003	0.004	0.439	0.000	0.179	0.045
LLP	0.000	0.004	-0.003	-0.000	-0.002	0.002	0.000	0.006	0.006
	0.007	0.015	0.102	0.009	0.009	0.300	0.260	0.040	0.049
NPL	0.001	-0.009	0.010	-0.002	-0.027	0.025	0.003	0.019	0.015
	0.013	0.020	0.009	0.024	0.033	0.013	0.002	0.065	0.098
Efficiency Channel									
Branch	-0.012	-0.017	0.004	-0.028	-0.058	0.031	0.015	0.042	0.026
	0.016	0.030	0.314	0.045	0.083	0.117	0.000	0.040	0.157
Empl	-0.010	-0.005	-0.005	-0.006	0.015	-0.021	-0.004	-0.020	-0.016
	0.016	0.054	0.543	0.063	0.109	0.435	0.008	0.476	0.550
Empl/Branch	2.067	0.249	1.818	0.208	0.303	-0.095	1.859	-0.054	-1.913
	14.005	1.450	0.009	1.758	0.998	0.702	0.005	0.871	0.009
Wages/Empl	-0.000	-0.001	0.000	-0.016	-0.066	0.051	0.016	0.066	0.050
	0.001	0.005	0.706	0.176	0.270	0.452	0.000	0.330	0.431
CIR	0.007	-0.031	0.039	0.004	-0.027	0.030	0.004	-0.005	-0.008
	0.057	0.094	0.005	0.141	0.058	0.033	0.356	0.794	0.648
Market Power Channel									
NIM	-0.001	-0.001	0.000	-0.001	-0.001	0.000	-0.000	0.000	0.000
	0.002	0.002	0.856	0.002	0.003	0.417	0.056	0.709	0.504
Int earned	-0.002	-0.004	0.002	-0.003	-0.004	0.002	0.000	-0.000	-0.001
	0.003	0.006	0.011	0.003	0.006	0.262	0.001	0.935	0.701
Int paid	-0.001	-0.003	0.002	-0.002	-0.003	0.001	0.001	-0.000	-0.001
	0.003	0.005	0.009	0.003	0.005	0.358	0.000	0.776	0.431
L(IBA)	0.035	0.053	-0.018	0.034	0.058	-0.024	0.001	-0.005	-0.006
	0.060	0.076	0.095	0.045	0.071	0.148	0.812	0.790	0.759
Market share	0.003	0.003	-0.000	-0.000	0.000	-0.001	0.003	0.003	-0.000
	0.025	0.049	0.953	0.007	0.007	0.647	0.005	0.657	0.966

Notes: This table shows summary statistics of dependent variables in the pre-period by ownership and treatment status. Tier1, NPL, Branch, Empl, Salaries, and Admin are defined as ratios to total assets. NIM, I-Inc., and I-Cost are defined as ratios relative to interest-bearing assets. NI-Inc. and NI-Cost are defined relative to total income.

Table 3.19: Frequency distribution of banks and M&A transactions over years according to treatment and ownership status for the full sample including non-merging banks.

	Non-Merging					Merging								
	Observations				Banks	Observations				Banks	Deals			
	Savings		Cooperatives			Savings		Cooperatives			Savings		Cooperatives	
	NT	T	NT	T	Total	NT	T	NT	T	Total	NT	T	NT	T
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1993	-	-	-	-	-	-	-	-	-	-	13	2	74	2
1994	204	6	342	15	567	26	18	239	7	290	7	11	62	7
1995	204	6	345	15	570	37	18	322	10	387	1	19	43	8
1996	204	6	345	15	570	43	31	362	12	448	6	6	62	4
1997	210	6	344	16	576	56	37	389	14	496	6	1	68	0
1998	210	6	343	16	575	57	35	361	4	457	4	0	110	0
1999	210	6	340	18	574	67	25	343	0	435	11	0	126	0
2000	209	7	339	19	574	73	6	321	0	400	15	0	175	0
2001	239	12	368	24	643	83	2	408	1	494	19	0	125	0
2002	239	12	367	25	643	85	1	420	2	508	17	0	102	0
2003	242	9	375	17	643	75	0	412	0	487	27	1	83	2
2004	242	9	375	17	643	84	5	402	2	493	13	0	53	0
2005	242	9	376	17	644	74	6	346	2	428	14	0	42	0
2006	242	9	374	17	642	68	7	285	3	363	7	0	31	0
2007	237	9	374	17	637	58	8	231	3	300	4	0	21	0
2008	237	9	374	17	637	43	3	175	2	223	2	4	33	0
2009	237	9	374	17	637	35	5	152	1	193	5	2	36	1
2010	240	6	377	14	637	26	7	165	2	200	1	1	17	1
2011	240	6	377	14	637	19	8	162	3	192	3	0	17	0
2012	240	6	377	14	637	16	8	143	3	170	2	0	18	0
2013	240	6	377	14	637	14	3	122	2	141	4	1	19	1
2014	240	6	376	14	636	12	2	90	1	105	1	0	29	0
2015	240	6	374	14	634	9	1	80	0	90	3	0	22	0
Total	5,048	166	8,013	366	13,593	1,060	236	5,930	74	7,300	185	48	1,368	26

Notes: This table shows observations, number of banks, and deals each year for the full sample of banks according to treatment and ownership status. In the column headers *NT* indicates non-treated and *T* treated observations. In Columns (1) to (4), and (6) to (9) observations of synthetic or original banks are counted. In Columns (5), and (10) observations are summed up per year. In Columns (11) to (14) mergers are counted in the year when they occurred.

TABLE 3.20: Frequency distribution of banks and M&A transactions over years according to treatment and ownership status for the sample merging banks in reformed states only.

	Observations				Banks	Deals			
	Savings		Cooperatives			Savings		Cooperatives	
	NT	T	NT	T	Total	NT	T	NT	T
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1993						7	2	13	2
1994	12	18	48	7	85	0	11	8	7
1995	10	18	63	10	101	0	19	6	8
1996	8	31	71	12	122	3	6	10	4
1997	10	37	73	14	134	4	1	18	0
1998	13	35	77	4	129			31	0
1999	22	25	82	0	129	3	0	33	0
2000	28	6	81	0	115	5	0	59	0
2001	40	2	138	1	181	4	0	44	0
2002	32	1	146	2	181	10	0	31	0
2003	28	0	139	0	167	15	1	31	2
2004	34	5	143	2	184	8	0	17	0
2005	33	6	119	2	160	7	0	14	0
2006	34	7	100	3	144	3	0	6	0
2007	29	8	80	3	120	1	0	8	0
2008	20	3	61	2	86	0	4	10	0
2009	15	5	58	1	79	2	2	7	1
2010	10	7	52	2	71	0	1	7	1
2011	7	8	50	3	68	1	0	8	0
2012	5	8	44	3	60	2	0	6	0
2013	6	3	37	2	48	1	1	7	1
2014	5	2	34	1	42			9	0
2015	3	1	31	0	35	2	0	5	0
Total	404	236	1,727	74	2,441	78	48	388	26

Notes: This table shows observations, number of banks, and deals each year for the sample of merging banks in reformed states according to treatment and ownership status. In the column headers *NT* indicates non-treated and *T* treated observations. In Columns (1) to (4) observations of synthetic or original banks are counted. In Column (5) observations are summed up per year. In Columns (6) to (9) mergers are counted in the year when they occurred.

Table 3.21: Real effects on related firms.

	Panel A							
	External financing cost				Investment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SB	0.0046***	0.0048***	0.0048***	0.0048***	-0.6931***	-0.7318***	-0.7810***	-0.8153***
	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.1062)	(0.1196)	(0.1272)	(0.1199)
RM (t=0)=1 × SB	-0.0023*				0.9249***			
	(0.0012)				(0.1402)			
RM (t=0,1)=1 × SB		-0.0025**				0.7218***		
		(0.0010)				(0.1800)		
RM (t=0,1,2)=1 × SB			-0.0015				0.7144***	
			(0.0011)				(0.1583)	
RM (t=0,1,2,3)=1 × SB				-0.0010				0.6105***
				(0.0011)				(0.1063)
Observations	51792	51792	51792	51792	51792	51792	51792	51792
Firms	18664	18664	18664	18664	18664	18664	18664	18664
Groups	12	12	12	12	12	12	12	12
Mean	0.0460				10.5330			
Median	0.0451				10.5330			
Standard Deviation	0.0314				10.5330			
Firm, Year-Region FE	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.0020	0.0021	0.0020	0.0020	0.0034	0.0035	0.0039	0.0038
R-squared (adjusted)	0.6862	0.6862	0.6862	0.6862	0.5700	0.5700	0.5702	0.5701

continued.

	Panel B							
	Employment				Leverage			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SB	-0.0511***	-0.0535***	-0.0528***	-0.0571***	0.0092	0.0084	0.0083	0.0070
	(0.0158)	(0.0166)	(0.0166)	(0.0162)	(0.0062)	(0.0059)	(0.0059)	(0.0063)
RM (t=0)=1 × SB	0.0260				-0.0020			
	(0.0205)				(0.0041)			
RM (t=0,1)=1 × SB		0.0302				0.0052		
		(0.0200)				(0.0066)		
RM (t=0,1,2)=1 × SB			0.0162				0.0035	
			(0.0135)				(0.0059)	
RM (t=0,1,2,3)=1 × SB				0.0261**				0.0072
				(0.0109)				(0.0065)
Observations	51792	51792	51792	51792	51792	51792	51792	51792
Firms	18664	18664	18664	18664	18664	18664	18664	18664
Groups	12	12	12	12	12	12	12	12
Mean		2.9304				0.7178		
Median		2.8904				0.7621		
Standard Deviation		2.8904				0.2242		
Firm, Year-Region FE	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (within)	0.0008	0.0009	0.0008	0.0009	0.0003	0.0003	0.0003	0.0004
R-squared (adjusted)	0.9532	0.9532	0.9532	0.9532	0.8398	0.8398	0.8398	0.8399

Notes: Clustered standard errors at the bank-level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The table shows results for regressions of Equation (3.2). We use four dependent variables: firms' (average) external financing cost calculated as total interest expenses over total liabilities; firms' investment which is the logarithm of total gross real investment; employment as the logarithm of the number of firms' employees; leverage which is the ratio of total liabilities to total assets. Regression results for the first two sets are presented in Panel A and the other two sets in Panel B. Standard errors in parentheses are clustered on the regional level.

TABLE 3.22: Description of the main variables.

Variable	Description
Main dependent variables	
RoE	Return on Gross Equity: Profit before Taxes to Total Gross Equity (See also *Profit, Equity Decomposition*)
RoNE	Return on Net Equity: Profit before Taxes to Total Net Equity (See also *Profit, Equity Decomposition*)
RoA	Return on Assets: Profit before Taxes to Total Assets
Main independent variables	
L(GDP)	Log (county GDP): Logarithm of GDP per county
Equity	Net Equity Ratio: Net Equity to Total Assets
LLP	Loan Loss Provisions: Loan Loss Provisions to Total Loans
CIR	Cost-Income-Ratio: Administrative Costs to Operating Income
Liquidity	Liquidity Ratio: Liquid Assets (Cash, Accounts receivable of banks with daily maturity) to Total Assets
Loans	Loans-Ratio: Total Loans to Non-Bank Costumers to Total Assets
NII	Non-Interest-Income Ratio: Non-Interest Income to Operating Income
Size	Quintile of Total Asset Distribution of resp. banking group
Equity Decomposition	
L(Gross Eq)	Log (Gross Equity): Sum of Net Equity, Total Accruals, and Other Equity
L(Net Eq)	Log (Net Equity): Sum of Nominal Equity, Retained Earnings, Current Earnings, and Other Retained Profits
L(Accruals)	Log (Total Accruals): Sum of Accruals for Pensions, Taxes, and Other Accruals incl. for Risks
L(Other Equity)	Log (Total Other Equity): Sum of Subordinated Debt, Participating Debt Obligations, and Equity-like Special Items
Profit Decomposition	
L(Profits)	Log (Profits before taxes): Operating and Non-operating Result
L(Total Rev)	Log (Total Revenues): Operating and Non-operating Revenues
L(Op Rev)	Log (Operating Revenues): Revenue earned on IBA, on Commissions, on the Trading Book, Other Operating Revenue, and Current Revenues
L(Non-Op Rev)	Log (Non-operating Revenues): Extraordinary Revenue, Appreciations, and Special items
L(Total Cost)	Log (Total Costs): Operating and Non-operating Costs
L(Op Cost)	Log (Operating Costs): Costs paid on IBA, on Commissions, on the Trading Book, Other Operating, and Administrative Costs
L(Non-Op Cost)	Log (Non-operating Costs): Extraordinary Costs, Depreciation, Special items
Risk Channel	
L(zscore)	Log (z-score): Profits minus Tier 1 equity over assets devided by Standard deviation of RoA based on a 5 year window
SD(RoA)	Standard Deviation of RoA: Standard Deviation of RoA based on a 5 year rolling window (min. 3 years available)
Tier1	Tier 1 Capital Ratio: Tier1 to Total Assets
LLP	Loan Loss Provisions Ratio: Loan Loss Provisions to Total Loans
NPL	Non-Performing-Loans Ratio: Non-Performing-Loans to Gross Loans to Costumers
Cost Channel	
Branch	Branch Ratio: Number of Branches to Total Assets (in Mil.)
Empl	Employees Ratio: Number of Employees to Total Assets (in Mil.)
Empl/Branch	Employees per Branch: Number of Employees per Branch
Wages/Empl	Wage Costs per Employee Ratio: Personnel Costs per Employee to Total Assets
CIR	Cost-Income-Ratio: Administrative Costs to Operating Income
Market Power Channel	
NIM	Net Interest Margin: Net Interest Income to Interest bearing Assets
Int. Earned	Average Interest earned on IBA: Interest Income to Interest bearing Assets
Int. Paid	Average Interest paid on IBA: Interest Costs to Interest bearing Assets
L(IBA)	Log (Interest Bearing Assets): Interbank Loans, Customer Loans, and Bonds and Securities
Market share	Market share of loans: Average share over all counties of banks' business area of average loans per branch of all branches in one county

continued.

Variable	Description
Deposits and loans	
L(Deposit)	Log (Deposits): Logarithm of Deposits to Costumers
L(Loans)	Log (Loans): Logarithm of Total Loans to (Non-Bank) Costumers
L(Consumer)	Log (Consumer Loans): Loans to private households (excl. real estate)
L(Comm)	Log (Commercial Loans): Loans to firms and private businesses (excl. the industrial and agricultural sector)
L(Industrial)	Log (Industrial Loans): Loans to firms in the industrial sector
L(Agri)	Log (Agricultural Loans): Loans to firms in the agricultural sector
L(Real Estate)	Log (Real Estate Loans): Loans to private households for the purpose of real estate
L(Municipal)	Log (Municipal Loans): Loans to the public sector on the municipal-level
L(State)	Log (State Loans): Loans to the public sector on the state-level
Decomposition of Gross Equity	
L(Nom Eq)	Log (Nominal Equity): Nominal Equity
L(Retained E)	Log (Retained Earnings): Retained Earnings
L(Other R)	Log (Other Retained Profits): Other Retained Earnings
L(Current R)	Log (Current Retained Profits): Profits from the P&L of the current accounting period
L(A Pension)	Log (Accruals for Pensions): Accruals for Pensions and similar obligations
L(A Taxes)	Log (Accruals for Taxes): Accruals for Taxes
L(A Risk)	Log (Other Accruals incl. for Risk): Other Accruals incl. accruals for credit risk made by LLP
L(Special Items)	Log (Special Items): Special Items incl. hidden accruals for "Special Banking Risk"
L(Subordinated)	Log (Subordinated Debt): Subordinated Debt
L(Participate)	Log (Debt with Participation Rights): Debt Obligations with Participation Rights
Decomposition of Total Costs	
L(Int Cost)	Log (Interest Costs): Costs of Interest Bearing Assets
L(Com Cost)	Log (Commission Costs): Costs on Commissions
L(Fin Cost)	Log (Financial Costs): Costs on Instruments on the Trading Book
L(Other Cost)	Log (Other Costs): Other operating costs
L(Admin Cost)	Log (Administrative Costs): Wage costs, other administrative costs, depreciation costs, and other taxes
L(Depr Cost)	Log (Depreciation Costs): Costs for Depreciation of Durables and Immaterial Goods
L(Exord Cost)	Log (Extraordinary Costs): Extraordinary Non-Operating Costs
Decomposition of Total Revenues	
L(Int Rev)	Log (Interest Revenues): Revenues on Interest Bearing Assets
L(Com Rev)	Log (Commission Revenues): Revenues on Commissions
L(Fin Rev)	Log (Financial Revenues): Revenues on Instruments on the Trading Book
L(Other Rev)	Log (Other Revenues): Other operating Revenues
L(Current Rev)	Log (Current Revenues): Other Current Operating Revenues
L(Appr Rev)	Log (Appreciation Revenues): Revenues on Appreciation of Durables and Immaterial Goods
L(Exord Rev)	Log (Extraordinary Revenues): Extraordinary Non-Operating Revenues
Decomposition of NIM	
L(Interbank)	Log (Interbank Loans): Total Interbank Loans
L(Customer)	Log (Customer Loans): Total Loans to Non-Bank Customers
L(Bonds & Sec)	Log (Bonds & Securities): Total Holdings of Fixed Income Bonds and Securities

Chapter 4

Die Auswirkung einer Höchstverschuldungsquote auf den Bankenmarkt *

Zusammenfassung: *Wir untersuchen mithilfe eines Portfoliomodells, inwiefern die Einführung einer weiteren Eigenkapitalnorm in Form einer Höchstverschuldungsquote den vom Baseler Ausschuss für Bankenaufsicht hierfür geäußerten Zielen gerecht werden kann. Das Modell zeigt, dass eine betroffene Bank, die ihren Gewinn unter einer bereits bestehenden Value-at-Risk-Eigenkapitalvorschrift maximiert, durch die Einführung gezwungen ist, sich stärker zu spezialisieren, und tendenziell dieselbe Allokation ihres Risikoportefeuilles wählt wie andere betroffene Banken. Entgegen der Baseler Zielsetzung würde der Gesamtbankenmarkt dadurch krisenanfälliger, da die Vielfalt der Geschäftsmodelle abnimmt.*

Abstract: *We analyze from a theoretical perspective to what extend the implementation of an additional bank capital regulation in form of a leverage ratio can meet the expectations the Basel Committee for Bank Supervision puts in it. The model shows that an affected bank, which maximizes profits under an existing value-at-risk capital charge, is forced by the implementation to specialize and has a tendency to choose the same allocation of its risk portfolio as other affected banks. Contrary to the aims of the Basel Committee, the banking market would be more prone to crisis because the diversity of business models decreases.*

4.1 Einführung

Seit der Finanzmarktkrise ab 2007 steht eine Verschärfung der Regulierungsvorschriften für Banken und insbesondere der Eigenkapitalvorschriften auf der politischen und regulatorischen Agenda. Im Dezember 2010 hat daher der Basler Ausschuss für Bankenaufsicht seine Vorschläge in dem als Basel III bekannten Papier zusammengefasst, auf dessen Grundlage auch die von

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der Europäischen Union mittlerweile beschlossenen Finanzmarktdirektiven (CRD IV und CRR) beruhen. Ein neues Element im Rahmen dieses Maßnahmenbündels ist die Einführung einer Höchstverschuldungsquote (Leverage Ratio) für Banken. Für die Berechnung der erforderlichen Eigenmittel sind bilanzielle und außerbilanzielle Posten aufzuaddieren und ungeachtet ihres Risikos bis zu einem bestimmten Prozentsatz mit Eigenkapital zu unterlegen. Aktuell vorgesehen ist eine Unterlegung von 3% mit Eigenkapital. Die politische Diskussion über die Höhe und die einzubeziehenden Posten ist allerdings noch längst nicht abgeschlossen.

Die Einschätzung des Risikos eines Unternehmens anhand des Leveragegrades ist durchaus üblich und die Limitation des Risikos durch solche einfachen Bilanzrelationen wie eine maximalen Verschuldungsquote kam in der ferneren Vergangenheit der Bankaufsicht vielfach zur Anwendung. Mit dem Basler Akkord von 1988 wurden solche Normen durch eine risikogewichtete Eigenkapitalunterlegung abgelöst. Einer solchen Norm kann man eine größere Präzision der Risikoabbildung zusprechen. Vor allem aber wurde die Gefahr gesehen, dass eine bloße bilanzielle Eigenkapitalquote Anreize für eine vermehrte Risikoübernahme setzen würde. Diese Auffassung wurde durch entsprechende modelltheoretische Überlegungen in der wissenschaftlichen Regulierungsliteratur unterstützt. Koehn und Santomero (1980) zeigen in einer einflussreichen Arbeit, dass ein Bankmanagement, das das Anlageportefeuille der Bank unter Risikoaversion optimiert, durch eine Leverage Ratio Anreize erhalten kann, ein riskanteres Portfolio zu wählen als ohne diese Form der Regulierung. In der Konsequenz wurden in der Folgezeit weitere Risiken einbezogen und komplexere Verfahren der Abbildung von Risiken eingeführt, um solchen adversen Anreizen möglichst wenig Spielraum zu lassen.

Es stellt sich die Frage, warum dieser Einwand gegen eine einfache Leverage Ratio heute nicht mehr gelten sollte. Der Hauptgrund hierfür ist wohl das veränderte regulatorische Umfeld. Im Gegensatz zu früher soll die Verschuldungsquote nicht als alleinige quantitative Eigenkapitalvorschrift, sondern als Ergänzung zu anderen risikobasierten Normen Verwendung finden. Der Fehlanreiz zur Risikoaufnahme soll durch die bestehenden risikogewichteten Normen korrigiert werden. Ob dies allerdings so gelingen kann, wurde bisher nur unzureichend untersucht. Daraus abgeleitet ist die Aufgabe der vorliegenden Arbeit, zu untersuchen, welche Wirkung auf das Risikoverhalten der Kreditinstitute eine ergänzende Höchstverschuldungsquote im Kontext der aktuellen Regulierungsvorschriften im Rahmen eines Portfoliomodells haben kann. Im Folgenden wird daher ein Modell vorgestellt, in dem die Auswirkung der Einführung einer Leverage Ratio auf die Portfoliowahl einer Bank analysiert wird, die bereits einer risikobasierten Eigenkapitalvorschrift unterliegt.

Der Basler Ausschuss nennt zwei Gründe für die Einführung einer solchen nicht-risikobasierten Norm (vgl. BIZ (2011), §16). Zum einen trage der hohe Verschuldungsgrad an sich bereits ein Risiko unabhängig davon, welche Geschäfte eine Bank tätige. Bereits ein geringer Werteverfall auf der Aktivseite genüge dann, um Verluste zu generieren, die das Eigenkapital übersteigen. In der Finanzkrise hatten die fallenden Kurse dazu geführt, dass Banken ihre Aktiva drastisch und schnell reduzieren mussten, um Verluste aufzufangen und Liquidität zu beschaffen. Sie führten sogenannte *firesales* aus, welche zusätzlichen Druck auf die bereits geschwächten Märkte ausübten. Dadurch gerieten weitere Banken in finanzielle Schwierigkeiten. Die Leverage Ratio solle nun dieses prozyklische Verhalten eindämmen, indem sie für einen angemesseneren Eigenkapitalanteil am Gesamtvermögen der Bank sorgt.

Die Schilderung impliziert, dass bestimmte Preisrisiken im Zuge der Ermittlung des regulatorischen Eigenkapitals unter den risikobasierten Regeln nicht hinreichend berücksichtigt wurden. So nennt Hellwig (2010) eine Reihe von Fällen, in denen die bankaufsichtlichen Risikomodelle versagen. Das zweite Motiv hinter der Einführung der Leverage Ratio ist daher, dass die Quote auch zur Eindämmung der Modellrisiken dienen soll, welche entstehen, wenn für die Kalkulation der Risikomaße ein fehlerhaftes Modell verwendet wurde. In dem im Folgenden dargestellten Modellansatz benutzt die Bankenaufsicht daher ungenaue Parameterwerte, um die Risiken der Banken zu bewerten, da sie nicht über die wahren Rendite-Risiko-Strukturen der Banken informiert ist.

Im Basel-II-Rahmenwerk werden verschiedene Konzepte der Risikomessung verwendet. Die Spannbreite reicht hier von auf die einzelne Position bezogenen Risikogewichten bis zu portfoliobasierten Value-at-Risk-Maßen. Im ersteren Fall werden einzelne kreditrisikobehaftete Bankgeschäfte ihrem Risikogehalt nach in bestimmte Klassen unterteilt, welchen dann ein einheitliches Gewicht zugeordnet ist. Höhere Risikoklassen sind entsprechend mit mehr Eigenkapital zu unterlegen (Gearing Ratio). Diese Risikogewichte standen vor allem im Zusammenhang mit der Staatsschuldenkrise unter Kritik und sollen in diesem Aufsatz nicht weiter betrachtet werden. Stattdessen fokussieren wir uns auf letzteren Fall, der insbesondere für die Messung von Marktrisiken relevant ist. Für die Bestimmung des Mindesteigenkapitals anhand des Value-at-Risk (VaR) werden die Risiken einer bestimmten Kategorie von Geschäften zunächst auf bestimmte Risikofaktoren aggregiert (risk mapping). Diese Risikofaktoren werden zu einem Portefeuille von Risiken zusammengefasst. Der Value-at-Risk eines solchen Risikoportefeuilles darf das vorhandene regulatorische Eigenkapital nicht überschreiten. Dabei ist der VaR eines Portefeuilles der Verlustbetrag der Portfoliorendite, welcher mit einer bestimmten Wahrscheinlichkeit in einem bestimmten Zeitraum nicht überschritten wird. Der Regulierer setzt demnach eine maximal zulässige Ruinwahrscheinlichkeit der Bank bzw. des Portefeuilles fest. Tendenziell können Banken durch Verwendung derartiger Modelle ihre Eigenkapitalanforderungen reduzieren, da die Aufsicht Anreize zur Entwicklung fortgeschrittener Verfahren der Risikomessung setzen möchte. Darüber hinaus genießen sie den Vorzug, dass Diversifikationseffekte zumindest für das betrachtete Teilportefeuille der Bank richtig berücksichtigt werden. Es besteht insoweit ein Anreiz zur Diversifikation.

Die Verwendung einer einfachen Leverage Ratio beinhaltet weder den Versuch, das Risiko der einzelnen Kreditrisikoposition richtig zu erfassen, noch berücksichtigt sie Diversifizierungseffekte, die sich mindernd auf das Gesamtrisiko auswirken können. Ist die Norm bindend und bestimmt daher die Portfoliowahl des Managements, wird das Management daher diese Aspekte nicht berücksichtigen. Damit verbleibt als ausschlaggebendes Kriterium der erwartete Ertrag der Einzelanlage. Wir modellieren die Auswirkungen dieser diametralen Tendenzen beider Normen auf die Portfolio-Wahl einer Bank.

Betrachtet wird dabei ein Portefeuille aus zwei Wertpapieren, wobei diese zwei Wertpapiere auch als einzelne Risikofaktoren, Anlageklassen, Großportefeuilles oder ganze Geschäftseinheiten oder Geschäftsfelder einer Bank interpretiert werden könnten. Wir leiten die optimale Entscheidung des Managements einer repräsentativen Bank für jeweils einen Regulierungsrahmen mit und ohne zusätzliche Leverage Ratio ab. Diese repräsentative Entscheidung des Managements des Einzelinstituts lässt sich auf alle Banken am Markt übertragen. Wenn daher die Eigenkapitalanforderungen so ausgestaltet sind, dass sie eine stärkere Spezialisierung der einzelnen Banken fördern, dann beeinträchtigen sie implizit auch die Diversität am Bankenmarkt insgesamt. Unter Diversität ist an dieser Stelle die Vielfalt und Unterschiedlichkeit der Geschäftsmodelle und risikopolitischen Positionierungen der Institute am Markt zu verstehen.

Die Diversität eines Finanzsystems hat einen bestimmenden Einfluss auf seine Stabilität bzw. Krisenanfälligkeit. Je ähnlicher die Banken einander sind, desto wahrscheinlicher ist auch, dass bei Auftreten der Krise einer Bank (z.B. durch hohe Wertverluste in einer bestimmten Vermögensklasse) auch eine Vielzahl anderer Institute betroffen ist. Die Auswirkungen einer zusätzlichen Leverage Ratio können demnach sehr ambivalent ausfallen. Zwar sorgt sie tendenziell dafür, dass im Krisenfall auf der Ebene des einzelnen Institutes mehr Haftungsmasse vorhanden ist. Verringert sich jedoch durch die zusätzliche Norm die Diversität des Finanzsystems, kann auf dieser Ebene eine höhere Krisenanfälligkeit resultieren. In unserem Modell zeigen wir, dass die gleichzeitige Regulierung mit einer Eigenkapitalnorm basierend auf einer präzisen Risikoabbildung wie Value-at-Risk und mit einer Leverage Ratio zu einer Konzentration gleicher Geschäftsmodelle am Bankenmarkt führt. Wird der Bankenmarkt selbst als umfassendes Gesamtportefeuille bestehend aus den Einzelportefeuilles der Banken betrachtet, impliziert diese Konzentration ein steigendes Risiko für den Markt als solchen. Aus der Perspektive einer Einlagenversicherung bedeutet dies eine Erhöhung der zu erwartenden Verluste. Eine Aufsichtsbehörde müsste befürchten, durch die zusätzliche Norm das systemische Risiko eines Bankensystems zu erhöhen.

Im Folgenden wird zunächst die vorhandene Literatur zu den Auswirkungen einer Höchstverschuldungsgrenze auf das Bankverhalten diskutiert. Dabei wird deutlich, dass eine genauere Analyse des gleichzeitigen Zusammenwirkens von risikoabhängigen und -unabhängigen Normen noch aussteht, obwohl die Implementierung eines solchen Systems bereits für 2018 geplant ist. Daraufhin wird ein Modell über die Portfoliowahl der Bank vorgestellt, anhand dessen wir ebendiese Wechselwirkung untersuchen. Im anschließenden Kapitel diskutieren wir die Ergebnisse des Modells mit Hinblick auf die Zielsetzungen der Bankenaufsicht.

4.2 Literaturüberblick

Die Literatur zur Anreizwirkung bankaufsichtlicher Verschuldungsquoten folgt in ihrem Entwicklungspfad der Entwicklung der regulatorischen Rahmenbedingungen. Studien aus den 1980er-Jahren betrachten das damals übliche Aufsichtssystem mit einer Leverage Ratio oder einer einfachen Gearing Ratio. Sie konfrontieren dieses System mit dem Entscheidungskalkül eines Bankmanagements, das an den Kriterien der damals dominanten Portfoliotheorie ausgerichtet ist. Danach ließ das Interesse an den Auswirkungen einer risikounabhängigen Norm nach, da diese nicht mehr dem Stand der

Regulierung entsprach. Erst mit der Finanzkrise ab 2007 und der aufkommenden Diskussion um die erneute Einführung einer Leverage Ratio entstand ein erneutes Interesse. Diese Arbeiten gehen auf die unterschiedlichsten Aspekte einer solchen Regelung ein und beschränken sich nicht auf die rein quantitative Anforderung und das Risikoverhalten der Bank.

In ihrem grundlegenden Ansatz verdeutlichen Koehn und Santomero (1980), dass ein Bankmanagement unter Risikoaversion als Ergebnis einer Optimierung des Anlageportefeuilles im Sinne von Markowitz (1952) ein höheres Risiko wählen kann, wenn es durch eine Leverage Ratio restringiert wird. Dies gilt für Banken, deren Management eine relativ geringe Risikoaversion an den Tag legt. Der positive Effekt des erzwungenen größeren Eigenkapitalpuffers auf die Konkurswahrscheinlichkeit kann durch die Bereitschaft, in riskantere Wertpapiere zu investieren, mehr als kompensiert werden. Darauf aufbauend leiten Autoren wie Kim und Santomero (1988) und Rochet (1992) die Überlegenheit risikogewichteter Eigenkapitalnormen zur Begrenzung der Risikobereitschaft von Banken her. Demgegenüber kritisieren Keeley und Furlong (1990) und Furlong und Keeley (1989) die Annahme der verwendeten Portfolio-Modelle, Einlagen stünden den Banken zum risikolosen Zins zur Verfügung, obwohl die Depositoren der Institute ein Ausfallrisiko tragen. Ergänze man das Modell um eine staatliche Einlagensicherung mit risikosensitiven Versicherungsprämien, so sei eine simple Verschuldungsquote ausreichend, um das Risikoverhalten im Sinne der Aufsicht zu restringieren. In Praxis und Theorie verlor jedoch mit der Umsetzung des ersten Baslers Akkord und den damit verbundenen risikoabhängigen Eigenkapitalanforderungen die Diskussion um die Leverage Ratio an Bedeutung.

Die Diskussion wurde wieder aufgenommen, seitdem die hohe Verschuldung von Banken als Krisenverstärker in der Finanzkrise identifiziert wurde. Neuere Studien betonen die Einfachheit einer derartigen Regel gegenüber einer risikobasierten Norm, und sie heben ihre antizyklische Wirkung hervor. Damit knüpfen sie an die Debatte um die prozyklische Wirkung risikosensitiver Eigenkapitalnormen an. So argumentieren Morris und Shin (2008) aufbauend auf dem Modell von Adrian und Shin (2008), in welchem die Verschuldung der Bank in einem vertragstheoretischen Modell hergeleitet und insbesondere die prozyklische Wirkung der Regelungen nach Basel II herausgearbeitet wird, dass eine Höchstverschuldungsquote die prozyklischen Tendenzen der Fremdkapitalaufnahme von Banken wirksam eindämmen könne. Jarrow (2013) zeigt, dass eine Leverage Ratio im Gegensatz zu bisherigen Überlegungen genau wie eine risikobasierte Norm die Konkurswahrscheinlichkeit kontrollieren kann. Er plädiert daher für die Verwendung der weniger komplexen Quote. In abgeschwächter Form zeigen Danielsson u. a. (2012), dass ebenfalls die simplere Norm vorzuziehen ist, wenn die Risikomaße fehlerhaft sind und in diesem Sinne das Modellrisiko schlagend wird. Estrella u. a. (2000) untersuchen hingegen gewichtete und ungewichtete Risikomaße empirisch auf ihre Vorhersagekraft für künftige Bankpleiten. Sie stellen fest, dass risikoadjustierte Maße zwar eine höhere Vorhersagekraft haben, dass eine simple Bilanzquote aber keinesfalls ein schlechter Prädiktor ist. Die weniger komplexe Norm sei aufgrund geringerer Implementierungskosten vorzuziehen. Aufgrund der einfachen Handhabung und Transparenz, die eine solche Quote haben könnte, argumentiert auch Blum (2008), dass sie den Bankenaufsehern eine bessere Verhandlungsposition gegenüber der

Bank einräumen und daher zu sozial angemesseneren Ergebnissen führen könne. Dies gelte unabhängig davon, ob die Leverage Ratio tatsächlich in Zukunft als quantitativ bindende Norm in Säule 1 überführt werde.

Demgegenüber finden sich in der neueren Literatur kaum kritische Beiträge zur Wiedereinführung einer bilanziellen Eigenkapitalquote für Banken. Ein Working Paper von Kiema und Jokivuolle (2010) zeigt, dass eine gleichzeitige Regulierung von Banken mit einer Leverage Ratio und dem Value-at-Risk-Ansatz des Internal Rating Based Approach (IRBA) zur Messung von Kreditrisiken zu einer verringerten Kreditvergabe und einer Umschichtung im Kreditportfolio hin zu riskanteren Kreditnehmern führen kann. Mit Ausnahme von Kiema und Jokivuolle (2010) finden sich außerdem auch keine weiteren Untersuchungen, welche die Wirkung einer Regulierung, die gleichzeitig aus risikobasierten und risikounabhängigen Normen besteht, analysieren. Unser Modell positioniert sich in dieser Lücke, indem wir die Auswirkung eines Regulierungsrahmen, der –wie für die endgültige Umsetzung von Basel III geplant– aus bindender Leverage Ratio und Value-at-Risk-Norm besteht, auf die Entscheidung von im Interesse der Eigentümer handelnden Bankmanagern untersuchen.

Dabei kommen wir zu dem Ergebnis, dass eine gleichzeitige Restriktion des Risikoverhaltens der Bankmanager durch eine Leverage Ratio und eine entwickeltere Eigenkapitalnorm mit einer präziseren Abbildung des Risikos der Gesamtbank systemische Risiken in Form korrelierter Bankportfolios hervorrufen kann. Damit knüpfen wir an eine Studie von Acharya (2009) an, in welcher systemisches Risiko als Korrelation der Renditen von Banken modelliert wird, die entsteht, wenn die Banken sich entscheiden, in den gleichen Sektoren zu investieren bzw. Kredite zu vergeben. Bezüge bestehen auch zur Arbeit von Wagner (2010), der allerdings nicht auf die Eigenkapitalregulierung eingeht. In Wagners Modellansatz treffen die Bankmanager eine Portfoliowahl. Streben sie dabei eine möglichst vollkommene Diversifikation an, ist zwar das Risiko des einzelnen Bankportefeuilles in diesem Sinne minimiert. Da aber alle Banken das gleiche Portefeuille wählen, ist der Bankenmarkt insgesamt starken systemischen Risiken ausgesetzt. Wagner argumentiert daher gegen eine möglichst weitgehende Diversifikation bei Banken. Seine Überlegung trägt aber nur dann, wenn die Institute über keine besonderen Spezialisierungsvorteile verfügen. Im nachstehenden Modellansatz gehen wir davon aus, dass die einzelne Institute über unterschiedliche Qualitäten verfügen und daher ihre Manager auch unter portfoliotheoretischen Gesichtspunkten sehr unterschiedliche Wahlentscheidungen treffen.

4.3 Ein Modell zur Portfoliowahl von Banken

Das folgende Modell beschreibt die Portfoliowahl eines Bankmanagements bei unterschiedlicher regulatorischer Rahmensetzung. Dabei ist eine zusätzliche Leverage Ratio daran zu messen, ob es gelingt, dadurch das systemische Risiko eines Bankensystems zu verringern. Referenzsystem ist ein Bankensystem, in welchem die Kreditinstitute nur einer risikosensitiven Eigenkapitalnorm unterworfen sind. Diese begrenzt im Sinne des Value-at-Risk die Ruinwahrscheinlichkeit der Banken auf ein bestimmtes, bankaufsichtlich erwünschtes Niveau. Die vorhandenen, sehr unterschiedlich gestalteten risikosensitiven Eigenkapitalnormen nach Basel II lassen sich als mehr oder weniger vollkommene Annäherung an eine solche Generalnorm begreifen.

4.3.1 Portfoliowahl unter Basel II

Wir nehmen bildhaft an, dass die Bank auf der Aktivseite ein Portfolio aus zwei riskanten Wertpapieren $i = \{X, Y\}$ hält. Die Renditen der Papiere sind normal verteilt mit $\phi(\mu_i, \sigma_i)$. Die Banken entscheiden über ihre offene Position x, y in beiden Anlagen X und Y. Diese Positionen müssen jeweils positiv sein. Damit orientieren wir uns an dem klassischen Portfoliomodell einer Bank wie in Koehn und Santomero (1980). Im Interesse einer einfachen Handhabung des Modells beschränkt sich die Betrachtung auf eine Periode.

Abweichend von Koehn und Santomero (1980) (und Wagner (2010)) nehmen wir allerdings an, dass Banken unterschiedliche Kostenstrukturen haben. Daher können manche Banken die erwartete Rendite aus einem riskanten Wertpapier bei geringeren Kosten erwirtschaften als andere. Jede Bank k hat daher unter Berücksichtigung dieser Kosten eine individuelle erwartete Rendite $\mu_{i,k}$. Die unterschiedliche Kostenstruktur in Bezug auf beide Wertpapiere stellt sich für jede Bank als individuelles Verhältnis der Renditen $\mu_{X,k}/\mu_{Y,k}$ dar. Zusätzlich zu den operativen Kosten hat die Bank Fremdkapitalkosten zu tragen. Sie zahlt den Einlegern den Zins r auf das aufgenommene Fremdkapital. Die Gewinnfunktion der Bank lautet daher:

$$\Pi_k = x_k \mu_{X,k} + y_k \mu_{Y,k} - rD_k \tag{4.1}$$

Auf der Passivseite der Bankbilanz stehen Einlagen und Eigenkapital. Wir nehmen an, dass einer Bank für den Zins r ein vollkommen preiselastisches Angebot an Depositen zur Verfügung steht. Sie kann daher so viel Fremdkapital in Form von Einlagen D aufnehmen wie sie möchte. Die fehlende Risikosensitivität der Fremdkapitalkosten kann wahlweise auf eine funktionierende Einlagenversicherung mit einer nicht-risikosensitiven Versicherungsprämie oder auf eine implizite Staatsgarantie zurückgeführt werden. Der knappe Faktor ist das Eigenkapital. Wir nehmen ferner an, alle Banken besitzen denselben Betrag E an Eigenkapital. Die Bilanzidentität einer Bank ist damit gegeben als:

$$E + D_k = x_k + y_k \tag{4.2}$$

Um ihren Gewinn zu maximieren, wählt jede Bank k simultan ihre Positionen in den riskanten Wertpapieren (x_k, y_k) und die Menge an Fremdkapital D_k, die sie aufnimmt. Bisher wurde jedoch noch kein Risiko in der Zielfunktion der Bank berücksichtigt. Ohne eine staatliche Regulierung würde daher ein Anreiz bestehen, unbeschränkt Fremdkapital aufzunehmen. Damit wird in vereinfachter Form eine Situation abgebildet, in der eine Bank sich in jedem Fall stärker verschulden möchte als dies von der Aufsicht gewollt ist. Daher führt die Bankenaufsicht eine Mindestkapitalanforderung in Form eines Value-at-Risk-Maßes ein:[1]

[1] Die Dächer über den Variablen zeigen im Folgenden an, dass diese von der Aufsicht festgelegt werden.

$$E \geq \widehat{VaR}_k = z\sigma(x_k, y_k) - \hat{\mu}(x_k, y_k) \quad \text{wobei} \quad z = -\phi^{-1}(1 - \hat{\alpha}) \tag{4.3}$$

Das Eigenkapital einer Bank muss daher mindestens so groß sein wie der Value-at-Risk des Portfolios, welches die Bank auf der Aktivseite hält. Dies gilt für ein von der Aufsicht bestimmtes Konfidenzniveau $\hat{\alpha}$, welches die maximal zulässige Ausfallwahrscheinlichkeit der Bank darstellt. Diese Norm unterliegt einem Modellrisiko. Sie ist unvollkommen derart, dass der Regulierer nicht über die individuellen Renditestrukturen der Banken informiert ist. Er kann daher für die Berechnung des regulatorischen Value-at-Risk anstatt der wahren Renditen $\mu_{i,k}$ nur solche Werte $\hat{\mu}_i$ annehmen, die er aufgrund seiner Erfahrung oder der von ihm ermittelten Daten aus der Vergangenheit für sinnvoll hält. Eine Individualisierung der Vorgaben ist nicht möglich oder nicht zulässig. Eine repräsentative Bank k löst daher das folgende Maximierungsproblem:

$$\begin{aligned} \underset{x_k, y_k, D_k}{\text{Max}} \quad & \Pi_k = x_k \mu_{X,k} + y_k \mu_{Y,k} - r D_k \\ \text{s.t.} \quad & E + D_k = x_k + y_k \\ & E \geq z\sigma(x_k, y_k) - \hat{\mu}(x_k, y_k) \end{aligned} \tag{4.4}$$

Da die Bilanzidentität aufgrund der Annahme endlos flexibler Fremdkapitalaufnahme nicht bindend ist, kann die Bestimmung der optimalen Einlagenmenge sequentiell erfolgen. Aus der Maximierung der Lagrangefunktion $L = \Pi_k(x_k, y_k) + \lambda\,(z\sigma(x_k, y_k) - \hat{\mu}(x_k, y_k) - E)$ ergeben sich die Bedingungen erster Ordnung nach dem Lagrangeparameter und die Relation:

$$\frac{\frac{\partial \pi}{\partial x}}{\frac{\partial \pi}{\partial y}} = \frac{z\frac{\partial \sigma}{\partial x} - \frac{\partial \hat{\mu}}{\partial x}}{z\frac{\partial \sigma}{\partial y} - \frac{\partial \hat{\mu}}{\partial y}} \tag{4.5}$$

Dabei steht auf der linken Seite der Gleichung das individuelle Renditenverhältnis $\mu_{X,k}/\mu_{Y,k}$ der Bank k. Durch Umformung erhalten wir eine konvexe Möglichkeitenmenge, welche alle Portfoliozusammensetzungen enthält, deren Value-at-Risk für das gegebene Eigenkapital den regulatorischen VaR nicht überschreitet.[2] Der Value-at-Risk aller Portfolios auf dem Rand dieser Menge entspricht exakt dem gegebenen Eigenkapital. Diesen Rand bezeichnen wir im Folgenden als Investitionsmöglichkeitskurve. Aus Sicht der Aufsicht sind aber auch solche Portfoliozusammensetzungen zulässig, die zu einem geringeren VaR führen. Für die ihren erwarteten Gewinn maximierende Bank sind aber nur solche Portfolios erstrebenswert, bei denen das vorhandene Eigenkapital vollständig zur Deckung von Risiken genutzt wird. Daher wählen sie genau den Punkt auf dem Rand, in dem sie die größten Gewinne erwirtschaften können. Abb. 4.1 veranschaulicht diesen Tangentialpunkt der Möglichkeitenmenge und einer Iso-Gewinngeraden mit der Steigung $\mu_{X,k}/\mu_{Y,k}$. Damit wird auch deutlich, dass alle Banken mit unterschiedlichen Renditeverhältnissen auch unterschiedliche Portfoliozusammensetzungen im Optimum wählen, da sie andere Tangentialpunkte besitzen.

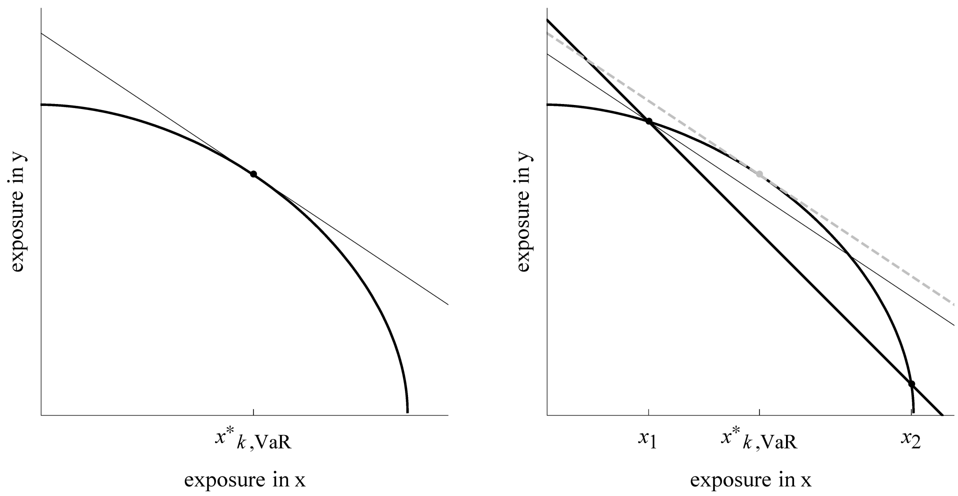
Damit erhalten wir in Gl. 4.5 eine eindeutige Lösung $x^*_{k,VaR}$ für das Problem aus Gl. 4.4. Die optimale Entscheidung ist in Abb. 4.1a für Parameterwerte dargestellt, bei welchen Y das riskantere Wertpapier ist. Im Ergebnis

[2] Die Berechnungen befinden sich im Anhang.

ABBILDUNG 4.1: Auswirkung der Leverage Ratio auf die optimale Portfoliowahl.

(A) Gewinnmaximum unter VaR Norm

(B) Gewinnmaximierung unter VaR Norm und Leverage Ratio



Anm.: Diese Abbildung zeigt die Auswirkung der Leverage Ratio auf die optimale Portfoliowahl einer Bank. Die durchgezogene schwarze Kurve zeigt die Investitionsmöglichkeitenkurve unter einer VaR Norm. Die graue durchgezogene Gerade zeigt die im Optimum maximal erreichbare Isogewinnlinie, wobei die gestrichelte Linie im rechten Bild die ehemals erreichbare Isogewinnlinie zeigt. Die schwarze durchgezogene Linie im rechten Bild zeigt die Restriktion durch die Leverage Ratio.

werden unter einer Value-at-Risk-Regulierung Banken ihre Portfolioallokation an ihren relativen Stärken orientieren, die sich im Renditenverhältnis äußern. Banken, die mit dem Wertpapier X eine höhere Rendite als mit Y erwirtschaften können, somit $\mu_{X,k}/\mu_{Y,k} > 1$, werden tendenziell auch eine größere Position in X relativ zu Y in ihrem Portfolio halten. Da eine bessere Diversifizierung durch den Value-at-Risk mit geringeren Eigenkapitalforderungen belohnt wird, halten sie nicht ausschließlich X. Entsprechendes gilt für Banken, die eine höhere Rendite mit Y erwirtschaften können. Die Aufsicht kann die Portfoliowahl der Banken durch die Festsetzung der Parameter für Renditen $\hat{\mu}_i$ und Standardabweichungen σ_i zur Kalkulation des regulatorischen VaR beeinflussen. Sie kann Banken Anreize geben, in ein bestimmtes Wertpapier zu investieren, indem sie für dieses eine relativ höhere Rendite oder geringere Standardabweichung heranzieht.[3]

4.3.2 Portfoliowahl unter Basel III: Einführung einer Höchstverschuldungsquote

Wir nehmen nun zusätzlich an, dass die Aufsicht eine simple nicht-risikogewichtete Höchstverschuldungsquote einführt, wodurch die weitere Bedingung $E \geq \hat{\beta}(x_k + y_k)$ zu dem Optimierungsproblem aus Gl. 4.4 hinzugefügt wird. Dabei beschränken wir uns vorerst auf den Fall, dass die Aufsicht die Höhe der Quote $\hat{\beta}$ so festlegt, dass sie tatsächlich für einige Banken auch unter Berücksichtigung der bereits vorhandenen VaR-Norm bindend ist. Die Frage nach der konkreten Höhe der Quote $\hat{\beta}$ wird im Vorfeld der Einführung einer solchen Norm natürlich äußerst kontrovers diskutiert. Es ist aber

[3]Siehe Erläuterungen zur Investitionsmöglichkeitenkurve im Anhang.

unmittelbar einsichtig, dass eine zu laxe Norm außer der Generierung von Transaktionskosten keinen ökonomischen Effekt hat und eine entsprechende Untersuchung obsolet wäre.

Unter der Voraussetzung, dass die Leverage Ratio ebenfalls bindend ist, müssen Banken nun zwei quantitative Eigenkapitalanforderungen gleichzeitig beachten, wobei jeweils die höhere Anforderung zu erfüllen ist. Um den sich nun ergebenden Investitionsmöglichkeitenraum zu bestimmen, muss zunächst geklärt werden, welche Norm in welchen Fällen die jeweils strengere ist, d.h. die höhere Eigenkapitalerfordernis stellt. Dafür definieren wir die beiden Schnittpunkte x_1 und x_2 der Investitionsmöglichkeitenkurve mit der Leverage-Ratio-Geraden (vgl. Abb. 4.1b), wobei $x_1 < x_2$ die Punkte bezeichnen, in welchen beide Vorschriften Anforderungen gleicher Höhe an die Bank stellen. Seien VaR die Höhe der Anforderung nach Value-at-Risk-Regulierung und LR nach Leverage Ratio, dann gilt in x_1 und x_2: $VaR = LR$. Daraus lassen sich drei Bereiche ableiten, die den neuen Rand des Investitionsmöglichkeitenraumes bestimmen. Für alle $x < x_1$ und alle $x > x_2$ ist $VaR > LR$. Deshalb bildet die konkave effiziente Investitionsmöglichkeitenkurve in diesen zwei Bereichen die Grenze des Möglichkeitenraums. Für alle $x_1 < x < x_2$ gilt dagegen $VaR < LR$. In diesem Bereich begrenzt die Gerade der Leverage-Ratio-Bedingung die mögliche Menge. Je strikter dabei die Quote gewählt wird, umso größer wird der Bereich, bis hin zu dem Punkt, dass alle Banken von der Leverage Ratio betroffen sind und die Norm strikt höhere Anforderungen stellt als die Value-at-Risk-Vorschrift. In einem solchen Extremfall würde die risikobasierte Regulierung obsolet. Wir beschränken uns daher im Folgenden auf Situationen, in welchen beide Normen weiterhin bindend sein könnten. Ein solcher Fall ist im rechten Teil der Abb. 4.1 abgebildet. Hier wird der mögliche Investmentraum von der Leverage Ratio Bedingung so durchschnitten, dass die Schnittpunkte die Eckpunkte des neuen Raums bilden.

Um die optimale Entscheidung der Bankleitung in diesen Grenzen herzuleiten, muss die Lagrangefunktion $L = \Pi_k(x_k, y_k) + \lambda(z\sigma(x_k, y_k) - \hat{\mu}(x_k, y_k) - E) + \nu(\hat{\beta}(x_k + y_k) - E)$ mit den Lagrangeparametern λ und ν optimiert werden.[4] Dies führte zunächst auf die bereits bekannte Lösung $x^*_{k,LR} = x^*_{k,VaR}$. Allerdings sind einige dieser Lösungen nicht mehr Teil des nun erreichbaren Möglichkeitenraums der Bank. Dies gilt für alle $x_1 < x^*_{k,VaR} < x_2$, also den Bereich zwischen den Eckpunkten des neuen Möglichkeitenraums, in welchem die Leverage Ratio die strengere Norm ist. Daher müssen alle Banken, für die die Leverage Ratio bindend wird, ihr Portfolio umstrukturieren. Sie wählen den Punkt mit der höchstmöglichen Iso-Gewinngeraden. Für alle Banken, die einen relativen Kostenvorteil beim Wertpapier X haben, ist dies der Punkt (x_2, y_2), in dem ihre Position in X größer ist als in Y. Alle Banken mit Vorteil bei Y wählen entsprechend das Portfolio (x_1, y_1). Die optimale Lösung für alle Banken, die einer gleichzeitigen Regulierung mit Value-at-Risk und Leverage Ratio unterliegen, ist daher gegeben als:

$$x^*_{k,LR} = \begin{cases} x_1 & \text{wenn} \quad x_1 < x^*_{k,VaR} < x_2 \quad \text{und} \quad \mu_{X,k}/\mu_{Y,k} < 1 \\ x_2 & \text{wenn} \quad x_1 < x^*_{k,VaR} < x_2 \quad \text{und} \quad \mu_{X,k}/\mu_{Y,k} > 1 \\ x^*_{k,VaR} & \text{wenn} \quad x^*_{k,VaR} \le x_1 \quad \text{oder} \quad x_2 \le x^*_{k,VaR} \end{cases} \tag{4.6}$$

[4] Die Herleitung der Lösung ist im Anhang C.II zu finden.

Wir stellen fest, dass alle Banken, die von der Höchstverschuldungsquote betroffen sind, entweder (x_1, y_1) oder (x_2, y_2) wählen. In Gl. 4.4 haben wir jedoch gesehen, dass alle Banken mit unterschiedlichen Renditeverhältnissen auch unterschiedliche Portfoliozusammensetzungen wählen. Im Ergebnis zeigt sich also, dass es nun einige Banken gibt, die exakt dieselbe Portfoliozusammensetzung wählen. Gleichzeitig ist diese neue Portfoliozusammensetzung weniger stark diversifiziert, d.h. jede der betroffenen Banken konzentriert sich stärker auf das Wertpapier, für welches sie einen relativen Kostenvorteil gegenüber dem anderen besitzt. Darüber hinaus zeigt sich, dass diese Banken nun geringere Gewinne erwirtschaften als zuvor. Schließlich hätten sie die Punkte (x_1, y_1) und (x_2, y_2) auch schon vor Einführung der Leverage Ratio wählen können, taten dies aber nicht, da ihr Gewinnoptimum ein anderes ist.

Im nächsten Kapitel wollen wir nun die Folgen einer solchen Entscheidung darlegen und Schlussfolgerungen für eine solide Bankenregulierung ziehen.

4.4 Diskussion der Ergebnisse

Der Baseler Ausschuss verfolgt mit der Einführung einer Verschuldungsobergrenze für Banken nach eigener Aussage zwei Ziele: Zum einen soll sie für eine bessere Kapitaldeckung in Krisenzeiten sorgen, zum anderen Modellrisiken risikobasierter Normen ausbessern. Zunächst werden wir daher untersuchen, inwiefern eine Leverage Ratio dies im Rahmen des hier vorgestellten Modells leisten kann. Anschließend möchten wir herausstellen, welche Implikationen die Ergebnisse des Modells für die Debatte rund um die Geschäftsmodelle von Banken haben. Dabei stellen wir heraus, dass insbesondere das in einigen Ländern Europas verbreitete Modell der Universalbank von den neuen Eigenkapitalregelungen betroffen sein wird.

4.4.1 Diskussion der Ergebnisse mit Blick auf die Zielsetzung des Baseler Ausschusses

In einem einfachen Modellrahmen können wir zeigen, dass Banken, die von der Einführung einer Leverage Ratio betroffen wären, gezwungen sind ihr Portfolio umzuschichten. Sie reduzieren dabei den Anteil in Geschäften oder Investments, bei denen sie keinen relativen Vorteil haben, und sie erhöhen den Anteil in dem Bereich, in welchem ihre Stärken liegen. Jedoch reduzieren alle betroffenen Banken dabei gleichermaßen ihr Engagement und damit ihre Gesamtbilanzsumme nur soweit wie nötig. Im Ergebnis führt es dazu, dass sie die exakt gleiche Portfolioallokation wählen wie eine größere Zahl ihrer Konkurrenten, während manche Allokationen vom Markt verschwinden. Die Diversität am Gesamtmarkt, hier verstanden als die Menge und Streuung unterschiedlicher Portfoliozusammensetzungen, nimmt damit ab. Alle Banken, die nun dieselbe Allokation wählen, besitzen damit perfekt korrelierte Portfolios, was laut Acharya (2009) und Wagner (2010) als Quelle systemischer Risiken angesehen werden kann. Würde beispielsweise eines der Wertpapiere von einem Schock getroffen und dessen Kurs infolgedessen einbrechen, hätte ein Teil der Banken eine vergleichsweise größere Position aufgrund ihrer stärkeren Spezialisierung und wäre weniger diversifiziert in andere Märkte, um die Verluste zu kompensieren. Verstärkend tritt hinzu, dass eine größere Anzahl an Banken auf dieselbe Art und im selben Umfang von einer solchen Krise betroffen wäre. Damit stehen unsere Ergebnisse in Widerspruch mit dem eingangs dargestellten Ziel des Basler Ausschusses, durch eine Reduktion der Verschuldung und damit Stärkung der Eigenkapitalposition solchen prozyklischen Prozessen entgegenzuwirken.

Das Modell beinhaltet einige stilisierte Annahmen, die hinterfragt werden müssen. So verfügen alle Banken über dieselbe Menge an Eigenkapital und können auch kein zusätzliches Kapital aufnehmen. Aber auch bei einem unterschiedlichen Kapitalstock oder bei Aufnahme zusätzlichen Kapitals ergibt sich nur eine Skalierung des Problems. Grundsätzlich gilt, dass jede Eigenkapitalnorm, die Risikomesszahlen ohne Berücksichtigung von Diversifikationseffekten addiert, die Anreize zu einer sachgerechten Diversifikation konterkariert. Eine maximale Verschuldungsquote ist nur das Extrembeispiel einer solchen Norm mit entsprechend problematischen Rückwirkungen auf die Wahl des Geschäftsmodells bei Banken.

Auf Ebene der Einzelinstitute erfüllt die zusätzliche Eigenkapitalvorschrift die vom Baseler Ausschuss geäußerte Erwartung, die Fremdfinanzierung als Risiko an sich zu begrenzen. Aus Gl. 4.2 lässt sich erkennen, dass die Bilanzidentität ebenso wie die Leverage-Ratio-Gerade eine Steigung von -1 hat. Banken mit einem Renditeverhältnis von ebenfalls -1 wählen ohne die zusätzliche Restriktion den größten Fremdkapitalanteil. Sie werden durch die Leverage Ratio gezwungen, diesen deutlich zurückzufahren.

Gelingt es einer Leverage Ratio, die Modellrisiken der Value-at-Risk-Norm sinnvoll einzudämmen? Eine unserer Modellannahmen ist, dass die Aufsicht nicht über die bankenspezifischen Kosten- und Gewinnstrukturen der Banken informiert ist. Zur Kalkulation des regulatorischen Value-at-Risk benutzt sie daher die von ihr ermittelten pauschalen Renditeerwartungen $(\hat{\mu}_X, \hat{\mu}_Y)$. Bei Verwendung dieser regulatorischen Input-Parameter halten alle Banken vor wie nach der Einführung der Leverage Ratio den regulatorischen Value-at-Risk exakt ein. Der "wahre" Value-at-Risk ihres Portfolios, der unter Verwendung ihrer individuellen erwarteten Renditen $(\mu_{X,k},\mu_{Y,k})$ zu ermitteln wäre, stimmt jedoch nicht mit diesem regulatorischen VaR überein. Dabei ist der "wahre" VaR der Portefeuilles von Banken, deren Kosten strikt besser sind als die regulatorischen Vorgaben $(\mu_{i,k} > \hat{\mu}_i)$, geringer als der regulatorische VaR. Diese Banken stellen kein Problem für die fehlerhafte Messung des Value-at-Risk dar, da ihre tatsächliche Ausfallwahrscheinlichkeit noch geringer ausfällt als vom Regulator erwünscht. Allerdings können sie ihr Eigenkapital nicht effizient nutzen.

Problematisch sind die Banken, welche strikt schlechtere oder teilweise schlechtere Kostensätze aufweisen als der Regulierer annimmt. Diese Banken können eine höhere als die aufsichtlich akzeptable Konkurswahrscheinlichkeit aufweisen. Die Frage stellt sich, ob diese Fehleinschätzung durch die Einführung einer zusätzlichen Leverage Ratio verringert werden kann. Auf eine formale Ableitung der Ergebnisse zu dieser Fragestellung soll an dieser Stelle aus Platzgründen verzichtet werden. Wir beschränken uns auf eine Darstellung der wesentlichen Argumente. Ausgangspunkt unserer Argumentation ist die Tatsache, dass in unserem Modellansatz das relative Verhältnis der Renditen $(\mu_{X,k}/\mu_{Y,k})$ die Portfoliowahl determiniert. Daher kann dieselbe Portfolioallokation sowohl von hinsichtlich ihrer Kostenstruktur strikt besseren wie auch strikt schlechteren Banken gewählt werden, sofern sie nur das gleiche Verhältnis der Renditen aufweisen. Gleichsam kann diese Allokation in jedem Punkt der Investitionsmöglichkeitenkurve liegen, nicht nur in dem Bereich, der durch die Leverage Ratio restringiert wird. Ob eine Bank hinsichtlich ihrer Kostenstruktur riskanter ist als von der Bankenaufsicht vermutet, hängt nicht davon ab, welche Verschuldungsquote sie aufweist. Die Idee, Modellrisiken mit einer Verschuldungsobergrenze zu begegnen, ist daher im betrachteten Modellrahmen wenig tragfähig, da es keine Anhaltspunkte dafür gibt, dass die Modellrisiken gerade bei hochverschuldeten Kreditinstituten besonders ausgeprägt sind. In unserem Modell wäre daher eine simple Verschärfung der bestehenden Value-at-Risk-Norm die bessere Methode, um Modellrisiken einzugrenzen.[5] Auf diesem Wege würde für alle Banken ein Sicherheitspuffer gegen Modellrisiken geschaffen, nicht nur für die Institute, für die die Leverage Ratio bindend wird. Auch dieses Vorgehen führt zu einer Verringerung der Bilanzsummen, die allerdings alle Institute erreicht.

Ein weiterer Aspekt, der in diesem Zusammenhang oft hervorgehoben wird (vgl. Schäfer, 2011), ist, dass eine risikounabhängige Norm naturgemäß keine bestimmten Anlageformen oder Geschäfte anderen vorziehe. Gerade aufgrund dieser Neutralität sei sie besonders geeignet, für angemessene Eigenkapitalanforderungen zu sorgen. Dieses Argument impliziert, dass risikoabhängige Normen irgendwelche Geschäfte, nach Möglichkeit aber solche mit einem geringen Risikobeitrag für die Gesamtbank, durch niedrigere Eigenkapitalanforderungen privilegieren. Dies ist unter einer Value-at-Risk-Norm tatsächlich der Fall und auch erwünscht. Wird für die Berechnung des VaR von Seiten der Aufsicht bei einem der beiden Wertpapiere fälschlicherweise ein besonders hoher Ertrag oder ein besonders niedriges Risiko angesetzt, entsteht für die Banken ein Anreiz, verstärkt in dieses Wertpapier zu investieren.[6] Soweit dieses Verhalten unter Einhaltung der VaR-Norm zu einer Ausweitung der Bilanzsumme führt, wirkt eine Leverage Ratio diesem Anreiz entgegen. Banken, die keine Spezialisten für das privilegierte Wertpapier sind, würden sich tendenziell gerne stärker diversifizieren als die Leverage Ratio ihnen erlaubt. Spezialisten würden sich dagegen tendenziell noch stärker spezialisieren, und dies gerade auch dann, wenn die Leverage Ratio für sie bindend ist. In dieser Hinsicht favorisiert eine Leverage Ratio eine stärkere Spezialisierung.

Der Verzicht auf eine Ungleichbehandlung ist bei ungleichen Sachverhalten, etwa einem unterschiedlichen Beitrag zum Gesamtrisiko der Bank, eben auch eine Privilegierung. Eine Leverage Ratio privilegiert in diesem Sinne bestimmte Anlageformen. Dass dies aus einer Risikoperspektive vollkommen willkürlich und orientiert am bloßen Beitrag eines Geschäftes zur Bilanzsumme geschieht, macht die Sache nicht besser. Wenn die Aufsicht der Meinung wäre, dass die verwendeten Parameter zu einer Unterschätzung des Risikobeitrags bestimmter Wertpapiere führen, ist der bessere Weg, die Kalibrierung des VaR-Modells entsprechend zu ändern. Dabei sollte man nicht übersehen, dass manche Privilegierungen politisch gewollt sind. Dies betrifft etwa die Behandlung von Staatsschulden in der Eigenkapitalnorm

[5] Die Aufsicht würde dazu die maximal zulässige Konkurswahrscheinlichkeit senken. Die Menge der zulässigen Investitionsmöglichkeiten schrumpft bei geringerem $\hat{\alpha}$ bzw. höherem z. Siehe Erläuterungen im Anhang C.I.

[6] Die Investitionsmöglichkeitenkurve dehnt sich entlang der Achse desjenigen Wertpapiers, für das $\hat{\mu}_i$ steigt und σ_i sinkt. Siehe Erläuterungen im Anhang.

und der neuen langfristigen Liquiditätsnorm (*net stable funding ratio*) oder die Besserstellung verbriefter Kreditforderungen gegenüber Buchforderungen. Sollten die Regierungen feststellen, dass eine maximale Verschuldungsquote den in dieser Privilegierung sich auswirkenden Interessen entgegenläuft, dürfen wir für die endgültige Fassung dieser Norm fest mit einer Ausnahmeregelung rechnen.

4.4.2 Leverage Ratio, Geschäftsmodelle und die Struktur von Bankensystemen

Der vorliegende Modellansatz beschreibt die Portfoliowahl eines Bankmanagements über einen stilisierten Markt mit nur zwei Wertpapieren. Die mit diesem Konzept verbundene Beschränkung der Relevanz des Ansatzes nehmen wir in Kauf, um aus einem rigiden portfolio-theoretischen Modell klare Aussagen ableiten zu können (vgl. allgemein zum Verhältnis von Relevanz und Rigidität in den Wirtschaftswissenschaften Kapitel II in Krahnen (1991)). Weitergehende Aussagen über die richtige Gestaltung der Eigenkapitalregulierung lassen sich ableiten, wenn man diese Wertpapiere als Repräsentanten für umfangreichere Aggregate, also z.B. bestimmte Risikofaktoren, Anlageklassen, Großportefeuilles oder ganze Geschäftseinheiten oder Geschäftsfelder ansieht. Weiterhin lassen sich die qualitativen Aussagen des Modells auch auf einen mehrdimensionalen Anlageraum übertragen. Vollzieht man diese methodischen Schritte, werfen die Ergebnisse unserer Modellanalyse einen schweren Schatten auf die Sinnhaftigkeit der Einführung einer maximalen Verschuldungsquote als Ergänzung zu den bestehen Eigenkapitalnormen. Aus der Banktheorie heraus ist bekannt, dass Banken zur Erfüllung ihrer ökonomischen Funktion gut diversifiziert sein sollten (vgl. Diamond (1984)). Die Analyse von Krisen aller Art führt auf die Aussage, dass Systeme sich dann als besonders stabil erwiesen, wenn sie einen hohen Grad an Diversität aufweisen. Dieses Argument lässt sich auch auf Finanzsysteme übertragen (vgl. Burghof (2011)). Beide Aspekte sollten sich in den Zielen einer sachgerechten Bankenaufsicht niederschlagen. Hinsichtlich beider Kriterien führt die Einführung einer zusätzlichen Leverage Ratio zu Beeinträchtigungen.

Auf der Ebene der einzelnen Bank bewirkt die Leverage Ratio eine größere Spezialisierung auf bestimmte Risiken und Geschäftsfelder. Spezialbanken werden dadurch gefördert, Universalbanken in ihren Entfaltungsmöglichkeiten beschränkt. Bestimmte Geschäftsmodelle mit hohem Diversifikationsgrad, in unserem Modell solche auf dem Abschnitt des Randes des Investitionsmöglichkeitenraumes zwischen x_1 und x_2, werden nicht mehr gewählt. Damit sind die Einzelinstitute eher schlechter diversifiziert. Berücksichtigt man, dass den vorhandenen Eigenkapitalnormen ein Modellrisiko innewohnt, so wirkt sich dieses, wie die Diskussion im vorstehenden Abschnitt gezeigt hat, in Verbindung mit einer Leverage Ratio nochmals verstärkend auf den Trend zu einer größeren Spezialisierung aus.

Auf der Ebene des Bankenmarktes fällt auf, dass eine Leverage Ratio ungeachtet der unterschiedlichen Spezialisierungsvorteile der einzelnen Institute zu einer Ballung der gewählten Geschäftsmodelle an den Schnittpunkten der Leverage-Ratio-Gerade mit der Investitionsmöglichkeitenkurve der VaR-Norm (bzw. bei einer sehr strengen Leverage Ratio mit der Abzisse, der Ordinate oder mit beiden) führt. Alle Kreditinstitute, die ohne diese zusätzliche

Norm ein Geschäftsmodell auf der Investitionsmöglichkeitenkurve der VaR-Norm zwischen x_1 und x_2 wählen würden, verschieben nun ihr Geschäftsmodell in diese Schnittpunkte. Der Effekt ist umso stärker, je restriktiver die Höchstverschuldungsquote gefasst ist. Damit wird zum einen der Übergang zu einem Spezialbankensystem gefördert und andererseits die Vielfalt der gewählten Geschäftsmodelle eingeschränkt. Damit erhöht sich die Wahrscheinlichkeit, dass eine große Zahl von Instituten gleichzeitig von krisenhaften Entwicklungen betroffen ist. Auch aus informationsökonomischen Gründen ist dies ein großes Problem: Einleger können nur schwer zwischen den verschiedenen Instituten unterscheiden und schließen möglicherweise von den bekannt gewordenen Problemen bei einem Institut auf ähnliche Probleme bei den ähnlich erscheinenden Banken. Diese Homogenitätsannahme ist ein wesentlicher Treiber bei der Verbreiterung des noch handhabbaren Runs auf eine einzelne Bank zum desaströsen Run auf das gesamte Bankensystem oder auf wesentliche Teile davon (vgl. Krümmel (1984)). Selbst wenn eine Leverage Ratio das Risiko der Einzelinstitute verringern würde, erhöht eine solche Verarmung in der Vielfalt der Geschäftsmodelle in einem Bankensystem das systemische Risiko.

Die Diversität von Bankensystemen hat auch eine nationenübergreifende Dimension. Wenn die Bankensysteme verschiedener Länder sich voneinander unterscheiden, wird eine Krise tendenziell nicht alle Länder gleichzeitig oder zumindest nicht in gleichem Ausmaß treffen. Diese Form der Diversität hat eine stabilisierende Wirkung auf das globale Finanzsystem. Eine zunehmend globale Bankenregulierung sollte sich daher neutral zu den unterschiedlichen Möglichkeiten der Ausprägungen der Gestaltung von Bankensystemen verhalten, um diese Diversität nicht zu gefährden. Aus dem Vorstehenden wird deutlich, dass die Einführung einer Leverage Ratio sich in dieser Hinsicht konterproduktiv auswirkt. Sie fördert einseitig die Entstehung von Spezialbankensystemen und behindert Universalbankensysteme. Ihr Beitrag zur Systemsicherheit ist daher auch in dieser Hinsicht negativ.

4.5 Fazit

Je gravierender eine Krise ausfällt, umso dringlicher ist natürlich auch das Bedürfnis, den Krisenursachen rasch und möglichst umfassend abzuhelfen. Die gefühlte Bedrohung führt auch zu einem gesteigerten Vertrauen in die durchschlagende Wirkung einfacher Antworten. Dies gilt auch für die Banken- und Finanzmarktaufsicht in der Finanzkrise. Zahlreiche alte und neue Regulierungsvorschläge werden hervorgeholt, seien dies nun das Verbot bestimmter Derivate, die Regulierung der Ratingagenturen oder des Hochfrequenzhandels, die Finanztransaktionssteuer oder eben die zahlreichen Neuregelungen im engeren Bereich der Bankenaufsicht und Eigenkapitalregulierung. Nach dem Grundsatz dass "viel auch viel hilft" werden immer neue Regulierungen der Finanzindustrie aufgebürdet. Das Ausmaß der Krise macht den Normensetzer immun gegen den Vorwurf der Überregulierung.

Viele dieser Regulierungsansätze sind sicher notwendig und hilfreich. Dennoch sollte jede Einführung einer neuen Regulierung von einem Abwägungsprozess begleitet sein: Wie gut verwirklicht die neue Norm die intendierten Zielsetzungen, und wie gravierend sind mögliche adverse Nebenwirkungen? Unsere Analyse kommt zu dem Ergebnis, dass die vorgeschlagene maximale Verschuldungsquote hinsichtlich beider Aspekte keine Bereicherung darstellt. Sie genießt zwar den Vorzug der Einfachheit, weist aber gerade deshalb eine sehr geringe Zielgenauigkeit auf. Vor allem aber unterstützt sie auf nationaler und internationaler Ebene eine Angleichung der Geschäftsmodelle und erhöht auf diesem Wege das systemische Risiko. Die Einführung einer maximalen Verschuldungsquote kann daher nicht das mühsame Streben nach einer sachgerechten Verbesserung der bestehenden, risikosensitiven Eigenkapitalnormen ersetzen. Im Gegenteil: Es gibt gute Argumente dafür, dass sie die Wirksamkeit bankaufsichtlicher Eigenkapitalnormen beeinträchtigt.

Appendix C

C.I Investitionsmöglichkeitenkurve

(Index k wird im Folgenden zur Vereinfachung weggelassen.)

In die regulatorische Value-at-Risk-Bedingung (vgl. Gl. 3) setzen wir für die Standardabweichung des Portfolios $\sigma(x,y) = \sqrt{x^2\sigma_x^2 + y^2\sigma_y^2 + 2xy\sigma_{xy}}$ und für die Rendite bewertet zu regulatorischen Renditegrößen $\hat{\mu}(x,y) = x\hat{\mu}_x + y\hat{\mu}_y$ ein und lösen nach y auf. Die Investitionsmöglichkeitenkurve (IOF) ist damit gegeben als:

$$IOF(x) \;=\; y = \frac{1}{d}\left((z^2\sigma_{xy} - \hat{\mu}_x\hat{\mu}_y)x - \sqrt{ax^2 + bx + c} - E\hat{\mu}_y\right) \tag{4.7}$$

wobei

$$\begin{aligned} a &= z^4(\sigma_{xy}^2 - \sigma_x^2\sigma_y^2) + z^2(\hat{\mu}_y^2\sigma_x^2 + \hat{\mu}_x^2\sigma_y^2 - 2\hat{\mu}_x^2\hat{\mu}_y^2\sigma_{xy})\,, \quad & c &= E^2z^2\sigma_y^2\,, \\ b &= 2Ez^2(\hat{\mu}_x\sigma_x^2 - \hat{\mu}_y\sigma_{xy})\,, & d &= \hat{\mu}_y^2 - z^2\sigma_y^2\,. \end{aligned}$$

Die Kurve beschreibt eine Ellipse. In unserem Modell sind jedoch nur Lösungen in $\mathbb{R}^+$ möglich. Unabhängig davon beschränkt eine Ellipse stets eine konvexe Menge. Das Verhalten der Kurve lässt sich am anschaulichsten anhand ihrer Achsenabschnitte zeigen:

$$IOF(0) = \frac{E}{z\,\sigma_y - \hat{\mu}_y} \quad \text{und} \quad IOF(x) = 0 \Leftrightarrow x = \frac{E}{z\,\sigma_x - \hat{\mu}_x}$$

Die Kurve dehnt sich immer entlang der Achse desjenigen Wertpapiers aus, dessen Rendite steigt oder Standardabweichung sinkt. D.h. bei derselben Menge an Eigenkapital kann dann bei vollständiger Spezialisierung eine größere Position in dem favorisierten Wertpapier als in dem anderen eingegangen werden.

C.II Herleitung der optimalen Lösung unter Basel III

Um zu zeigen, dass x^*_{LR}, y^*_{LR} die optimale Lösung der Lagrangefunktion $L = \pi_k(x,y) + \lambda(z\sigma(x,y) - \hat{\mu}(x,y) - E) + \nu(\hat{\beta}(x+y) - E)$ ist, muss x^*_{LR}, y^*_{LR} die vier Karush-Kuhn-Tucker-Bedingungen (KKT) erfüllen. Dies ist zugleich notwendig wie auch hinreichend für ein Optimum eines konvexen Optimierungsproblems.

$$\begin{array}{lrl} 1. & \frac{\partial\pi}{\partial x} + \lambda\left(z\frac{\partial\sigma}{\partial x} - \frac{\partial\hat{\mu}}{\partial x}\right) + \nu\hat{\beta} & = 0 \\ & \frac{\partial\pi}{\partial y} + \lambda\left(z\frac{\partial\sigma}{\partial y} - \frac{\partial\hat{\mu}}{\partial y}\right) + \nu\hat{\beta} & = 0 \\ 2. & z\sigma(x^*_{LR}, y^*_{LR}) - \hat{\mu}(x^*_{LR}, y^*_{LR}) - E & \leq 0 \\ & \hat{\beta}(x^*_{LR}, y^*_{LR}) - E & \leq 0 \\ 3. & \lambda & \geq 0 \\ & \nu & \geq 0 \\ 4. & \lambda\left(z\sigma(x^*_{LR}, y^*_{LR}) - \hat{\mu}(x^*_{LR}, y^*_{LR}) - E\right) & = 0 \\ & \nu\left(\hat{\beta}(x^*_{LR} + y^*_{LR}) - E\right) & = 0 \end{array} \tag{4.8}$$

Da außer in den zwei Schnittpunkten x_1 und x_2 nie beide Nebenbedingungen gleichzeitig mit Gleichheit erfüllt sind, besagt die Komplementaritätsbedingung (4.), dass entweder $\lambda = 0$ und $E = \hat{\beta}(x + y)$, was für alle $x_1 \leq x \leq x_2$ gilt, oder $\nu = 0$ und $E = z\sigma - \hat{\mu}$ für alle $x \leq x_1$ und $x \geq x_2$. Ist $\lambda = 0$, können wir λ aus KKT (1.) berechnen als

$$\lambda = \frac{\partial\pi/\partial x - \partial\pi/\partial y}{z\,(\partial\sigma/\partial y - \partial\sigma/\partial x) + \partial\hat{\mu}/\partial x - \partial\hat{\mu}/\partial y} = 0\;. \tag{4.9}$$

Da $\partial\pi/\partial x - \partial\pi/\partial y = \mu_{X,k} - \mu_{Y,k}$ ist und weder von x noch y abhängig ist, ist $\lambda \neq 0$ für alle x. Daher kann es keine optimale Lösung in diesem Bereich der Investmentmöglichkeitenkurve geben. Eine Ausnahme gibt es: Für Banken mit dem Renditeverhältnis $\mu_{(X,k)}/\mu_{(Y,k)} = 1$ gilt $\mu_{(X,k)} - \mu_{(Y,k)} = 0$. In diesem Spezialfall lässt sich keine eindeutige Lösung finden. Diese Banken könnten ihr Optimum in irgendeinem Punkt $x_1 \leq x^*_{LR} \leq x_2$ wählen. Um eine Lösung zu bestimmen, bleibt daher nur der zweite Fall der KKT (4.), in dem $\nu = 0$ und $E = z\sigma - \hat{\mu}$. Aus KKT (1.) können wir dann erneut λ herleiten als:

$$\lambda = \frac{\partial\pi/\partial x}{z\,\partial\sigma/\partial x - \partial\hat{\mu}/\partial x} = \frac{\partial\pi/\partial y}{z\,\partial\sigma/\partial y - \partial\hat{\mu}/\partial y} \tag{4.10}$$

Dies entspricht exakt der Bedingung aus der Optimierung ohne Leverage Ratio (vgl. Gl. 4.5).

Chapter 5

Basel III capital requirements and heterogeneous banks

Abstract: *I develop a theoretical model to investigate the effect of simultaneous regulation with a leverage ratio and a risk-weighted ratio on banks' risk taking and banking market structure. I extend a portfolio choice model by adding heterogeneity in productivity among banks. Regulators face a trade-off between the efficient allocation of resources and financial stability. In an oligopolistic market, risk-weighted requirements incentivize banks with high productivity to lend to low-risk firms. When a leverage ratio is introduced, these banks lose market shares to less productive competitors and react with risk-shifting into high-risk loans. While average productivity in the low-risk market falls, market shares in the high-risk market are dispersed across new entrants with high as well as low productivity.*

5.1 Introduction

Since the introduction of Basel III, banks are constrained by competing minimum capital requirements. Banks are subject to the revised risk-based capital framework of Basel II and the non risk-based leverage ratio. The intention of this dual approach was to curb model risk inherent in applied risk-weights and to counteract their pro-cyclicality (BCBS, 2010). This paper sheds light on unintended consequences, especially on the allocation of market shares.

Although the new rules equally apply to all banks, competing capital requirements favor some banks at the expense of others. The simultaneity of both rules implies that the leverage ratio constraint binds only for some banks (BCBS, 2016). The question is, what kind of banks are affected. The rationale of capital requirements is to favor safe banks and charge risky banks. But being risky can be a feature of many traits. Still the question is, what kind of banks are risky.

To address this question, I develop a model with heterogeneous banks where differences in productivity determine banks' optimal strategies under competing capital constraints and hence riskiness. This paper leans on the idea, forwarded in trade theory by Melitz (2003), that productivity differences play an important role in shaping firms' optimal strategies. I extend a portfolio choice model by adding heterogeneity in productivity among banks in the form of differences in marginal costs. Banks choose their strategy in a high-risk and a low-risk credit market with Cournot competition. I find that risk-weighted capital requirements incentivize banks with high productivity to specialize on low-risk loans. When the leverage ratio is introduced, these banks lose market shares in the low-risk market to less productive competitors and react with risk-shifting into high-risk loans as in Koehn and Santomero (1980), and Kim and Santomero (1988).

Theoretical work on capital requirements so far ignored the role of productivity in banks' decision about risk because studies focused on models with representative banks (VanHoose, 2007). Nevertheless, the relationship between productivity and risk taking received much attention in empirical work although the evidence is yet inconclusive. On the one hand, the efficiency-risk hypothesis[1] claims that more productive banks expect higher future profits and thus need a smaller capital buffer. Hence, they can afford a riskier strategy (Berger and Patti, 2006; Altunbas et al., 2007). On the other hand, the charter-value hypothesis claims that more productive banks protect these higher profits by choosing less risky strategies (Fiordelisi et al., 2011). Therefore, it is unclear from the perspective of financial stability whether market shares should be allocated to the most productive banks. Due to frictions, e.g. asymmetric information and entry barriers, the banking industry is already prone to allocative inefficiency and X-inefficiency causing welfare losses (Vives, 2001a; Berger et al., 1993). If more productive banks were also safer banks, regulation should reallocate market shares to their favor. If not, a social planner might face a trade-off between an efficient allocation of resources and financial stability when setting new regulatory guidelines (Allen and Gale, 2004).

In this model, productivity creates positive charter value and market power. In the unregulated equilibrium, market shares are allocated according to productivity. The bank with the highest productivity is the market leader in the market for high-risk loans and the market for low-risk loans. Since productivity differences are exogenous to the model, it can be categorized in the light of Efficient Structure theory pioneered by Demsetz (1973). The presence of risk-weighted capital requirements, however, introduces a complementarity between both types of loans (Repullo and Suarez, 2004). As a consequence, banks with high productivity specialize on low-risk loans, and hence average productivity in the high-risk market is rather low. Banks with lower productivity do not have to provide more equity for taking the same risks, yet their default probabilities are higher due to lower charter values. The Basel II equilibrium is therefore characterized by concentration of high-risks in low-productivity banks. The introduction of the leverage ratio affects both markets differently and tends to ameliorate this unwanted concentration. In the low-risk market, the most productive banks lose market shares to competitors with lower productivity so that average productivity falls. In the high-risk market, however, banks with low productivity enter but also the most productive banks gain market shares so that the market is less concentrated.

I rely on the model of Kiema and Jokivuolle (2014) and extend it

[1] Note that empirical studies prefer the term efficiency over productivity, since most of them estimate the distance of a bank to the efficient production frontier. Nevertheless, it would be confusing to talk about efficiency in a theoretical context, since in a model every production decision is the result of an individual optimization.

by introducing heterogeneity and an oligopolistic market.[2] Kiema and Jokivuolle (2014) model banks' optimal portfolio choice with Basel III capital requirements. As in Repullo and Suarez (2004) and this paper, banks specialize under Basel II. After the leverage ratio is introduced, low-risk banks choose a mixed portfolio so that, overall, bank portfolios are more alike. They study the role of the leverage ratio as a backstop to model risk and find that this role is impeded by less diverse portfolio choices. A recent paper by Smith et al. (2017) also examines banks' risk choices under the competing rules and evaluates whether the leverage ratio effectively reduces the probability of insolvency. They contrast the risk-taking incentives of the leverage ratio with the increase of loss absorbing capital and show that the positive effect of higher capital outweighs the negative effect of increased risk-taking. They test their implications empirically and find that banks become more stable after the announcement of the leverage ratio. I find a similar result which indicates that the leverage ratio can contribute to financial stability. I find that, in switching from the Basel II to the Basel III equilibrium, default probabilities of most banks decline, at least as long as realizations of a common systematic risk-factor not exceed a threshold.[3] Beyond this threshold, default rates in the high-risk market are so high that even the most productive banks are closer to default.

Thus my work contributes to the literature on capital requirements and risk, in particular to the recent literature on the interaction of competing capital requirements. Wu and Zhao (2016) and Blum (2008) show that the leverage ratio complements the risk-weighted ratio given that banks are opaque and able to misreport their actual risk level to the regulators. Brei and Gambacorta (2016) and Gambacorta and Karmakar (2016) study the joint effect of both requirements and demonstrate the countercyclical quality of the leverage ratio. Furthermore, I contribute to the literature which is using heterogeneous banks. Apart from macroeconomic models with heterogeneous agents, e.g. Choi et al. (2015), only few microeconomic banking models consider heterogeneity. Barth and Seckinger (2013) show how heterogeneous monitoring costs introduce a selection problem in the banking market. Other studies consider two distinct types of banks. Hakenes and Schnabel (2011) find that smaller banks take more risks if big banks have a competitive advantage by choosing the internal ratings-based over the standardized approach in the Basel II framework.

The remainder of this paper is organized as follows. Section 5.2 introduces the main assumptions and setting of the model. Section 5.3 gives the baseline equilibrium without regulation. In section 5.4 banking regulation is introduced and the equilibria with risk-weighted and competing capital requirements are derived. Section 5.5 discusses the results and possible limitations. Section 5.6 concludes.

5.2 The model

Consider a Cournot-Nash game with N banks competing in two markets. There is a market for low-risk loans and a market for high-risk loans. Banks

[2] In perfect competition with productivity differences the most productive bank which has the lowest marginal costs would effectively be a monopolist.

[3] The reverse holds for the subgroup of banks that were specialized on high-risk loans in the Basel II equilibrium and switch to the mixed portfolio strategy in the new equilibrium.

have different unit costs and no fixed costs. Unit costs of bank i are denoted as c_i. In what follows, we rank banks according to their costs such that the bank with the lowest unit costs is denominated as bank 1 whereas bank N has the highest unit costs.

$$c_1 < c_2 < \cdots < c_N \tag{5.1}$$

Each market represents one of two types of entrepreneurs, risky and less risky entrepreneurs. Once in the game, there is perfect information about types but these costs can be interpreted as screening costs that banks have to incur in order to discern high- and low-risk entrepreneurs. Further, these costs reflect monitoring and administrative costs, such as employment of loan officers, back-office administration of the loan portfolio, or maintenance of monitoring processes. Therefore, low costs represent a more efficient production technology. Banks that are able to operate their loan portfolio at lower costs are more productive. The model introduces productivity differences of banks in the simplest form of differing cost functions.[4] This leads to asymmetric Nash-equilibria where optimal strategies depend on marginal costs.

Let the strategy of bank i be $q_i = (q_{h,i}, q_{l,i})$. Let $Q_{-i} = (Q_{h,-i}, Q_{l,-i})$ denote aggregate quantities of all banks except bank i and $Q = (Q_h, Q_l)$ the total aggregate supply of loans in the respective markets. Aggregate supply determines inverse demand $r_\eta(Q_\eta)$[5] from entrepreneurs of type $\eta = \{h, l\}$. Inverse demand functions are continuous, monotone, and concave.

$$\begin{aligned} r_h(Q_h) &= r_h\left(\sum_{i=1}^{N} q_{h,i}\right), & r_l(Q_l) &= r_l\left(\sum_{i=1}^{N} q_{l,i}\right) \\ r_h'(Q_h) &< 0\,, & r_l'(Q_l) &< 0 \\ r_h''(Q_h) &\leq 0\,, & r_l''(Q_l) &\leq 0 \end{aligned} \tag{5.2}$$

Entrepreneurs demand a loan of size 1 if the interest rate is lower than their expected payoff. I assume expected payoffs are distributed such that it entails inverse demand functions of the described kind. Entrepreneurs, however, have limited liability. They repay the interest rate only if their projects are successful. If their project defaults, entrepreneurs pay nothing to the bank, i.e. loss given default is 1. Banks use average probabilities of success for each type of loan to take this into account.

To determine success probabilities of entrepreneurs, I use the representation by Repullo and Suarez (2004) and Kiema and Jokivuolle (2014) of the Vasicek model (Vasicek, 1987; Vasicek, 2002). This risk model underpins the framework of risk-sensitive capital requirements of the Basel II accord. There is a common risk factor captured in z as well as idiosyncratic risk ϵ_j that are both standard normally distributed. Successes of high- and low-risk projects are correlated and ρ is the correlation parameter. The project of

[4] Heterogeneous productivity is exogenous in the model. This is inspired by trade models with heterogeneous firms (Melitz, 2003). It is applicable since I do not want to study what constitutes productivity differences among banks but rather how they influence the portfolio decision and distribution of market shares. Caveats concerning this assumption are discussed in section 5.5.

[5] All interest rates are absolute returns. Therefore, think of r_h as $1 + \mathit{interest}_h$, etc..

entrepreneur j is successful if a latent random variable $x_j \leq 0$, where

$$\begin{aligned} x_j &= \zeta_\eta + \sqrt{\rho}\, z + \sqrt{1-\rho}\, \epsilon_j \qquad \eta = \{h, l\} \\ z &\sim N(0,1), \quad \epsilon_j \sim N(0,1)\ . \end{aligned} \tag{5.3}$$

The two types differ in ζ_η which represents the financial vulnerability of entrepreneurs of type η and $0 < \zeta_l < \zeta_h$. If banks know the types of entrepreneurs, they know ζ_l and ζ_h. Consequently, the unconditionally expected probability to default of loans of type η is $\overline{PD}_\eta = \Phi(\zeta_\eta) = Pr(\zeta_\eta + \sqrt{\rho} z + \sqrt{1-\rho}\epsilon_j > 0)$, where Φ is the cumulative distribution function of the standard normal distribution. Let the expected probability of success be $p_\eta = 1 - \overline{PD}_\eta$, respectively. Note that $p_h < p_l$ since low-risk entrepreneurs are less likely to default. Assume that investing in the riskier project has a higher expected yield so that

$$1 < p_l r_l(Q_l) < p_h r_h(Q_h) \tag{5.4}$$

I assume depositors are insured and consequently ignorant of bank risk. They supply an inexhaustible amount of savings at an interest rate r_d. The deposit rate could be the value of an outside option of depositors, e.g. holding cash or a safe asset instead of investing their endowment in a bank. Depositors will then invest in banks whenever these offer a deposit rate at least as high as their outside option. For simpler notation, I define marginal costs as

$$MC_i = c_i + r_d\ . \tag{5.5}$$

Each banker is equally endowed with an amount of equity e. Let r_e denote the opportunity costs of equity capital and let it be higher than the opportunity costs of depositors, s.t. $r_d < r_e$.[6] Banks are only operated if expected profits from intermediation are higher than the outside option of bankers. Therefore, I assume that bankers have to invest their equity in the bank in order to employ the banking technology. Banks' balance sheet constraint is given by

$$e + d_i = q_{h,i} + q_{l,i}\ . \tag{5.6}$$

Let expected payoff of bank i be expected profits of intermediation minus opportunity costs given as

$$\Pi_i(q_i, d_i, e) = p_h r_h(Q_h) q_{h,i} + p_l r_l(Q_l) q_{l,i} - c_i(q_{h,i} + q_{l,i}) - r_d d_i - r_e e\ . \tag{5.7}$$

In addition, each bank has a capacity limit W_i which is finite but arbitrarily high so it cannot produce more than W_i in any market. This assumption ensures that banks' strategy sets are bounded in the unregulated case and is not crucial once regulation is introduced. Furthermore, banks are not allowed to take short positions in neither loans nor deposits, so that $q_i \geq 0$ and $d_i \geq 0$.

5.3 Unregulated equilibrium

Consider the optimization problem of a bank without capital requirements. By inserting Eq. (5.5), and Eq. (5.6) in Eq. (5.7) and rearranging, the

[6] This assumes that equity is costly contrary to the discussion in Admati et al. (2013).

problem of bank i is

$$\begin{aligned} &\underset{q_i}{\text{Max}}\ \Pi_i(q_i) \qquad \text{s.t.} \quad \Pi_i(q_i) \geq (r_e - r_d)e \quad \text{and} \quad 0 \leq q_i \leq W_i \quad \text{where} \\ &\qquad \Pi_i(q_i) = (p_h r_h(Q_h) - MC_i)q_{h,i} + (p_l r_l(Q_l) - MC_i)q_{l,i} \end{aligned} \tag{5.8}$$

Because of the flat deposit rate due to the deposit insurance and the fact that debt financing is cheaper than equity financing, banks have strong incentives to increase their balance sheet size through levering if these are not balanced by regulation or market forces.

In a Cournot game though, competition ensures that bank size stays limited. If any bank expands its loan business the interest rates decrease for all banks so that competitors reduce their loan business. All in all, the lower interest rates fall, the less attractive is an expansion strategy. Furthermore, the lower interest rates fall, the fewer banks are able to participate in the loan market because some banks' marginal costs would be too high to make a profit. Consequently, the least productive banks do not provide loans in equilibrium and some less productive banks only provide loans in the high-risk market where expected revenues are higher. The unregulated equilibrium is summarized in following proposition.

Proposition 1 (Unregulated equilibrium).
In an unregulated equilibrium, optimal aggregate supply in the high-risk market is Q_h^* provided by a subset $\{1, \dots, \nu_h\}$ with $\nu_h \in \{1, \dots, N\}$ of banks at interest rate $r_h(Q_h^*)$, and aggregate supply in the low-risk market is Q_l^* provided by a subset $\{1, \dots, \nu_l\}$ with $\nu_l < \nu_h$ and $\nu_l \in \{1, \dots, N\}$ of banks at interest rate $r_l(Q_l^*)$.

Aggregate supplies are a result of best-response correspondence of optimal strategies where strategy q_i^* of bank i is $(q_{h,i}^*, q_{l,i}^*)$ with

$$q_{\eta,i}^* = max\left[0, \frac{p_\eta r_\eta(Q_\eta^*) - MC_i}{\nu_\eta p_\eta r_\eta(Q_\eta^*) - \sum_{i=1}^{\nu_\eta} MC_i} Q_\eta^*\right]. \tag{5.9}$$

More productive banks gain higher market shares and are bigger than less productive banks.

Proof. Proof is in the appendix. □

The fraction in Eq. (5.9) represents the market share of bank i in market η. It equals the ratio of the rent that bank i can earn on a loan of type η relative to total rents earned in the market. All banks weight their revenue with the same unconditional success probabilities p_η and earn in equilibrium the same market interest rates. Therefore, bank 1 with the lowest marginal costs MC_1 will have the highest market share in the market for low-risk loans and the market for high-risk loans, whereas bank ν_h has the lowest market share in the market for high-risk loans and its marginal costs MC_{ν_h} are only slightly smaller than or equal to the market interest rate $r_h(Q_h)$.

Therefore, Cournot competition with heterogeneous cost functions gives reasonable implications of how productivity advantages translate into scale and market power advantages. Since productivity differences are exogenous to the model, it can be categorized in the light of Efficient Structure theory pioneered by Demsetz (1973).

5.4 Regulating heterogeneous banks

5.4.1 Necessity to regulate and determinants of bank default

Given that bank defaults result in high social cost for the economy, the objective of a social planner is to avoid any bank default. A bank i defaults if the realization of systematic risk z is higher than the critical value $z_{i,crit}$ defined as

$$\pi_i(c_i, q_i, r(Q), z_{i,crit}) - r_d d_i(q_i, e) = 0 \tag{5.10}$$

where

$$\begin{aligned}\pi_i(c_i, q_i, r(Q), z) = &(1 - PD_l(z))\ r_l(Q_l)q_{l,i} + \\ &(1 - PD_h(z))\ r_h(Q_h)q_{h,i} - c_i(q_{h,i} + q_{l,i})\end{aligned}$$

and $PD_\eta(z)$ is the default probability of projects of type η conditional on the realization of systematic risk z. In a portfolio with many loans of type η with roughly equal size, the fraction of defaulting loans in such a portfolio converges to $PD_\eta(z)$ (Elizalde et al., 2005). Rearranging $\Pr(\zeta_\eta + \sqrt{\rho}\ z + \sqrt{1-\rho}\ \epsilon_j > 0)$ gives

$$PD_\eta(z) = \Pr\left(\epsilon_j > -\frac{\zeta_\eta + \sqrt{\rho}z}{\sqrt{1-\rho}}\right) = \Phi\left(\frac{\zeta_\eta + \sqrt{\rho}\ z}{\sqrt{1-\rho}}\right)\ . \tag{5.11}$$

Under any distribution of risk, here it is the standard normal distribution, extreme realizations of systematic or idiosyncratic risk are possible, so that default cannot be prevented with absolute certainty no matter how much loss absorbing capital is available to a bank. The micro-prudential approach of the Basel Committee is to set a maximal admissible default probability. It is a well known shortcoming of portfolio models that they do not provide an innate explanation for regulation. Nevertheless, portfolio models mirror best the approach chosen by the current regulator. I therefore have to assume that regulation is necessary to tame banks leveraging.

Assumption 1 (Necessity of regulation)**.** *In the unregulated equilibrium, all banks show unacceptable high default probabilities. The regulator implements capital requirements to lower default probabilities.*

Based on Eq. (5.10), I distinguish three channels that determine banks' default probabilities. First, critical value ($z_{i,crit}$) depends directly on banks' heterogeneous costs (c_i). Lower costs create higher charter values and hence resilience. Second, critical value ($z_{i,crit}$) depends on the chosen strategies (q_i) which in turn depend on marginal costs. This channel is more comprehensible if split into two: A portfolio allocation channel and a leverage channel. The former concerns the share of high-risk loans to total loans in the portfolio, i.e. $\gamma_i = \frac{q_{h,i}}{q_{h,i}+q_{l,i}}$. A higher portfolio share γ_i is riskier. This channel is addressed by the risk-weighted ratio. The leverage channel concerns the size of the portfolio, i.e. $q_{h,i} + q_{l,i}$, under the assumption that equity is fixed for all banks. Risks that arise through this channel are limited by the leverage ratio. Third, critical value ($z_{i,crit}$) depends on market interest rates ($r(Q)$) which are indirectly also functions of marginal costs.[7] Higher

[7]One could write $\pi_i(c_i, q_i(c_i), r(Q(\sum q_i(c_i))), z)$.

interest rates increase charter values and therefore loss absorbing capacity of banks.[8]

Since marginal costs are difficult to measure once we leave the simple model world, it would hardly be feasible to write regulatory rules contingent on productivity. Furthermore, it is unclear ex-ante whether the regulator should tax or relieve more productive banks taking into account the indirect effects of productivity on portfolio strategy, market power, and size. The regulator so far conditions capital requirements on the portfolio strategy and size but not on productivity. This is reasonable since portfolio allocations and leverage are easily observable.

5.4.2 Basel II equilibrium

The Basel II accord introduced risk-sensitive capital requirements to avoid the risk-shifting phenomenon described by Koehn and Santomero (1980), Kim and Santomero (1988) and others. They show that if capital requirements are not risk-sensitive, banks have incentives to shift their portfolio towards riskier assets. Following the Basel II approach for credit risk, banks must categorize their assets with respect to their riskiness into different buckets for which different risk-weights are applied. In the Standard Approach these weights are set by the regulator. In the Internal Ratings based Approach banks are allowed to use internal risk-models to provide expected default probabilities or more inputs, e.g. loss given default, for the calibration of the weights.

This model describes the IRB approach where default probabilities of loans of a certain type are used to calculate capital requirements. The model is static so that the maturity of all loans is one. The risk-weighted requirement is constructed such that the probability that unexpected losses of the asset portfolio exceed available equity is lower than a threshold α, i.e. the admissible probability of default set by the regulator. However, the regulator implicitly ignores heterogeneity here. As is shown later, banks can have default probabilities above α if heterogeneity is taken into account.[9] Let us assume the regulator sets α for some representative bank. As a results, equity is insufficient to cover unexpected losses with probability α for that bank.

The regulator infers the critical value of systematic risk $z_\alpha = \Phi^{-1}(1-\alpha)$ from Eq. (5.11) such that $Pr(z \leq z_\alpha) = 1-\alpha$. Consequently, if the representative bank holds at least $PD_\eta(z_\alpha)$ equity for each loan of type η, it is able to cover losses with probability $1-\alpha$. In detail, the capital requirement has two components: loan loss provisions for expected losses ($\overline{PD}_\eta$) and equity capital for unexpected losses ($PD(z) - \overline{PD}_\eta$). In this model the risk-adequate capital requirement for a loan of type η simplifies to

$$\beta_\eta = PD_\eta(z_\alpha) = \Phi\left(\frac{\zeta_\eta + \sqrt{\rho}\,\Phi^{-1}(1-\alpha)}{\sqrt{1-\rho}}\right) . \tag{5.12}$$

The requirement is additive for both types of loans given that banks hold a well-diversified portfolio within each class of loans (Vasicek, 2002). Since

[8] Formal derivation of these channels are in the proof of lemma 4 in the appendix.

[9] Confer Kiema and Jokivuolle (2014) for a detailed account of how default probabilities are effectively restricted by Basel II capital requirements in a representative bank model.

high-risk firms have a higher financial vulnerability ($\zeta_h > \zeta_l$), the capital requirement for high-risk loans is higher than for low-risk loans. The risk-weighted capital constraint of Basel II is given by

$$e \geq \beta_h q_{h,i} + \beta_l q_{l,i} \quad \textit{where} \quad 0 < \beta_l < \beta_h < 1\,. \tag{5.13}$$

Adding the risk-weighted capital constraint to bank i's optimization problem and introducing μ_i as the shadow price of being constrained by the requirement gives

$$\begin{aligned} \underset{q_i,\mu_i}{\text{Max}} \quad & \Pi_i(q_i,\mu_i) = (p_h r_h(Q_h) - MC_i)q_{h,i} + (p_l r_l(Q_l) - MC_i)q_{l,i} \\ & \qquad\qquad - \mu_i\left(\beta_h q_{h,i} + \beta_l q_{l,i} - e\right) \\ \text{s.t.} \quad & \Pi_i(q_i,\mu_i) \geq (r_e - r_d)e\,, \quad 0 \leq q_i \leq W_i\,, \quad 0 \leq \mu_i \end{aligned} \tag{5.14}$$

Whereas in the unregulated equilibrium competitive pressures are the main force limiting bank size and determining the bank portfolio composition, under assumption 1 capital requirements pose much stricter limits on size and composition. They introduce complementarity between both types of loans. Because the requirement in Eq. (5.13) is additive, banks enjoy no immediate advantage by diversifying their portfolio between asset classes. Therefore, a specialized portfolio is always better than a mixed portfolio strategy if it is feasible (Repullo and Suarez, 2004; Kiema and Jokivuolle, 2014). Moreover, whenever

$$p_l r_l(Q_l) - MC_i > \frac{\beta_l}{\beta_h}\left(p_h r_h(Q_h) - MC_i\right) \tag{5.15}$$

bank i has incentives to fully specialize on low-risk loans. Let $\Pi_i^s(q_{h,i}, q_{l,i})$ denote the expected payoff of bank i implementing strategy s where $s = h$ when bank i specializes on high-risk loans and $s = l$ when the bank specializes on low-risk loans. Solving Eq. (5.15) for MC_i gives the cutoff marginal costs of the bank with the lowest productivity which specializes on low-risk loans. It is therefore the cutoff of the low-risk market, denoted as $\widetilde{MC^l}$, and defined s.t.

$$\begin{aligned} &\Pi_i^l(0, \tfrac{e}{\beta_l}) \geq \Pi_i^h(\tfrac{e}{\beta_h}, 0) \qquad \forall\, i \in \{1, ..., N\} : MC_i \leq \widetilde{MC^l} \\ &\text{where} \quad \widetilde{MC^l} = \frac{\beta_h p_l r_l(Q_l) - \beta_l p_h r_h(Q_h)}{\beta_h - \beta_l}\,. \end{aligned} \tag{5.16}$$

An equilibrium can only exist if this cutoff is positive and there are banks that specialize on low-risk loans as well as banks that specialize on high-risk loans. It follows that in equilibrium capital requirements pose an upper bound on the interest rate on high-risk loans relative to the interest rate of low-risk loans, i.e.

$$p_l r_l(Q_l^*) < p_h r_h(Q_h^*) < \tfrac{\beta_h}{\beta_l} p_l r_l(Q_l^*)\,. \tag{5.17}$$

Nevertheless, not all banks are active in equilibrium. Of all banks with marginal costs above the cutoff $\widetilde{MC}^l$ only banks with marginal costs below expected revenue $p_h r_h(Q_h)$ are profitable. Let the cutoff marginal costs for the high-risk market be denoted as

$$\widetilde{MC}^h = p_h r_h^*(Q_h^*) \ . \tag{5.18}$$

Some of the banks in the high-risk market are constrained by the risk-weighted ratio, i.e. $e = \beta_h q_{h,i}^*$, while others are not constrained, i.e. $e > \beta_h q_{h,i}^*$. The constrained strategy h is only feasible for banks with non-negative shadow prices, i.e. $\mu_i \geq 0$ according to Eq. (5.14). There is a negative relation between MC_i and μ_i. More productive banks are able to produce the highest quantities in an unregulated equilibrium, hence they face higher shadow prices of being constrained by capital requirements. Let the cutoff marginal costs between constrained and unconstrained banks in the high-risk market be denoted as

$$\widetilde{MC}^{\mu_h} = p_h r_h + \frac{e}{\beta_h} p_h r_h' \ . \tag{5.19}$$

The equilibrium is illustrated in the upper half of Figure 5.2 and is summarized in Proposition 2.

Proposition 2 (Basel II equilibrium)**.**
With additive risk-weighted capital requirements, if Eq. (5.17) *holds and*

$$\begin{aligned} -(p_h r_h(Q_h^*) - p_l r_l(Q_l^*)) &< \frac{e}{\beta_h} p_h r_h'(Q_h^*) \quad < 0 \ , \\ -\frac{\beta_l}{\beta_h - \beta_l}(p_h r_h(Q_h^*) - p_l r_l(Q_l^*)) &< \frac{e}{\beta_l} p_l r_l'(Q_l^*) \qquad < 0, \end{aligned} \tag{5.20}$$

more productive banks specialize on low-risk loans while less productive banks specialize on high-risk loans, i.e. optimal strategies in equilibrium are

$$(q_{h,i}^*, q_{l,i}^*, \mu_i^*) = \begin{cases} \left(0, q^l, \mu_i^l(MC_i)\right) & \text{if} \quad MC_i \leq \widetilde{MC}^l \ , \\ \left(q^h, 0, \mu_i^h(MC_i)\right) & \text{if} \quad \widetilde{MC}^l < MC_i \leq \widetilde{MC}^{\mu^h} \ , \\ \left(q_{h,i}^{uc}(MC_i), 0, 0\right) & \text{if} \quad \widetilde{MC}^{\mu^h} < MC_i \leq \widetilde{MC}^h \ , \\ (0,0,0) & \text{if} \quad \widetilde{MC}^h < MC_i \ , \end{cases} \tag{5.21}$$

where a subset $\{1, \dots, \nu_l\}$ *of banks with* $MC_i \leq \widetilde{MC}^l$ *for all* $i \in \{1, \dots, \nu_l\}$ *offer aggregate supply of low-risk loans* Q_l^* *at interest rate* $r_l^*(Q_l^*)$, *and a subset* $\{\nu_l + 1, \dots, \nu_h\}$ *of banks with* $\widetilde{MC}^l < MC_i \leq \widetilde{MC}^h$ *for all* $i \in \{\nu_l + 1, \dots, \nu_h\}$ *offer aggregate supply of high-risk loans* Q_h^* *at interest rate* $r_h^*(Q_h^*)$.

Proof. It follows from Eq. (5.16) and the arguments above. Derivation of the conditions is in the appendix. □

Given these equilibrium strategies, it is possible to determine default probabilities. The direct effect of productivity advantages on the critical value of systematic risk $z_{i,crit}$ which is defined in Eq. (5.10) is positive, i.e. banks with lower marginal costs *ceteris paribus* have higher profits. Positive profits constitute positive charter value and add to loss absorbing capacity. Therefore, when comparing banks that specialize on the same type of loans, the relationship between productivity and default probability is straightforward. These banks have the same strategy and earn the same interest rate. Hence, banks with lower marginal costs have lower default probabilities than banks with higher marginal costs that are active in the same loan market. When comparing specialists on the high-risk and low-risk market, the relationship between productivity and default probabilities is not straightforward. The portfolio allocation channel and leverage channel take opposite directions. On the one hand, high-risk specialists have a riskier investment strategy and higher costs. On the other hand, they are less levered. Additionally, the interest rate channel works in favor of banks specializing on high-risk loans. If we impose a stricter limit on the upper bound of the high-risk market interest rate than Eq. (5.17) and therewith limit the influence of the interest rate channel, a relationship can be clearly stated. In that case, the direct cost channel and the portfolio channel outweigh the leverage channel, so that banks with higher productivity are definitely less likely to default. Lemma 1 summarizes.

Lemma 1. *In equilibrium, more productive banks have lower default probabilities than less productive banks in the same market, i.e.*

$$\begin{aligned} z_{i,crit} &> z_{i+1,crit} \quad \forall\, i \in \{1, ..., \nu_l\} : \; q^*_{l,i} > 0 \\ z_{i,crit} &> z_{i+1,crit} \quad \forall\, i \in \{\nu_l + 1, ..., \nu_h\} : \; q^*_{h,i} > 0 \, . \end{aligned} \tag{5.22}$$

If $p_h r_h(Q^*_h) < \frac{\beta_h}{\beta_l} p_h r_l(Q^*_l)$*, more productive banks have lower default probabilities even across markets, i.e.*

$$z_{i,crit} > z_{i+1,crit} \quad \forall\, i \in \{1, ..., N\} : \; q^*_i > 0 \, . \tag{5.23}$$

Proof. Proof is in the appendix. □

5.4.3 Basel III equilibrium

Among other measures aimed at capital adequacy, the Basel III accord introduced the leverage ratio. The motives of the regulator were driven by macro- as well as micro-prudential considerations. In order to comply, banks need to back up 3% of their total exposure with Tier 1 equity capital. Total exposure includes on-balance as well as off-balance sheet assets. The leverage ratio capital constraint of Basel III is given by β according to

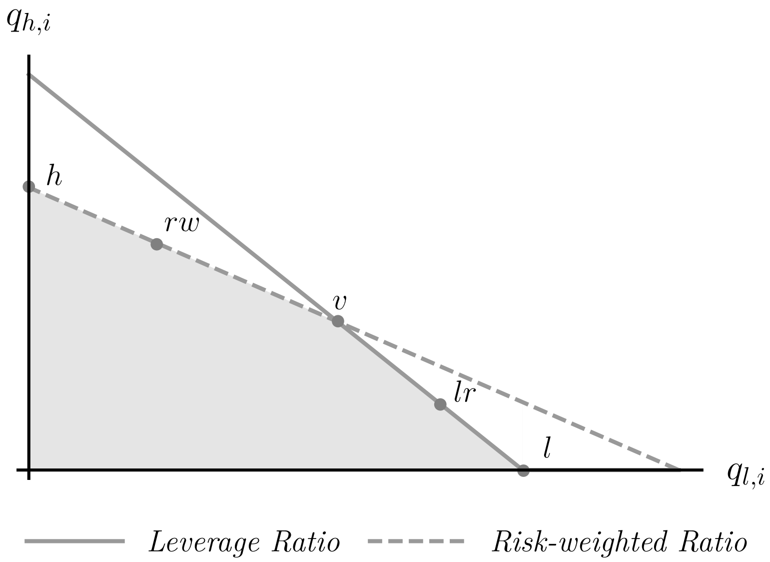
$$e \geq \beta\,(q_{h,i} + q_{l,i}) \quad \textit{where} \quad 0 < \beta_l < \beta < \beta_h < 1 \, . \tag{5.24}$$

Adding the leverage ratio to the risk-weighted capital constraint in bank i's optimization problem and introducing λ_i as the shadow price of being constrained by the leverage ratio gives

$$\begin{aligned} \underset{q_i,\mu_i,\lambda_i}{\text{Max}} \quad & \Pi_i(q_i,\mu_i,\lambda_i) = (p_h r_h(Q_h) - MC_i)q_{h,i} + (p_l r_l(Q_l) - MC_i)q_{l,i} \\ & \qquad - \mu_i\,(\beta_h q_{h,i} + \beta_l q_{l,i} - e) - \lambda_i\,(\beta\,(q_{h,i} + q_{l,i}) - e) \\ \text{s.t.} \quad & \Pi_i(q_i,\mu_i,\lambda_i) \geq (r_e - r_d)e \, , \quad 0 \leq q_i \leq W_i \, , \quad 0 \leq \mu_i \, , \quad 0 \leq \lambda_i \end{aligned} \tag{5.25}$$

The additional constraint reduces the set of feasible strategies. The shaded area including the bounding line segments in Figure 5.1 illustrates the set of feasible strategies of bank i. Since the leverage ratio poses extra costs on banks specializing on low-risk loans, it sets incentives to shift the portfolio

FIGURE 5.1: Feasible quantities and strategy choices under both capital requirements.



Notes: This figure shows all feasible combinations of high-risk and low-risk loans (shaded area) when both capital requirements are in place. The solid line represents the limitations of portfolio choice due to the leverage ratio. The dashed line represents the limitations of portfolio choice due to the risk-weighted ratio. The points depict possible strategy choices. Point h shows the strategy with specialization in high-risk loans, point rw shows a mixed portfolio strategy which is constrained by the risk-weighted ratio, point v shows the mixed vertex-strategy which is constrained by both ratios, point lr shows the mixed portfolio strategy which is constrained by the leverage ratio, and point l shows the strategy with specialization in low-risk loans. Unconstrained strategies would lie inside the shaded polygon or its borders on the axes.

toward riskier assets. Therefore, a mixed strategy is better for banks that previously specialized on low-risk loans. These banks change their strategy to strategy v which is the mixed portfolio exactly on the vertex in Figure 5.1 where both constraints are binding. For the remainder of banks it is still optimal to specialize on high-risk loans as long as it is feasible. Let $\widetilde{MC}^l$ denote the cutoff marginal costs between banks choosing strategy v and banks choosing strategy h. Since only banks that choose strategy v offer loans to low-risk entrepreneurs, $\widetilde{MC}^l$ defines the marginal costs of the bank with the lowest productivity that still participates in the low-risk market. Let $\widetilde{MC}^l$ be defined by

$$\begin{aligned} &\Pi_i^v(q_{h,i}^v, q_{l,i}^v) \geq \Pi_i^h(\tfrac{e}{\beta_h}, 0) \qquad \forall\, i \in \{1, ..., N\} : MC_i \leq \widetilde{MC}^l \\ &\text{where} \quad \widetilde{MC}^l = \frac{\beta_h p_l r_l(Q_l) - \beta_l p_h r_h(Q_h)}{\beta_h - \beta_l} \, . \end{aligned} \tag{5.26}$$

Furthermore, only banks with non-negative shadow prices μ_i are able to choose strategy h. The cutoff marginal costs for constrained banks in the high-risk market is therefore given as $\widetilde{MC}^{\mu^h}$ defined in Eq. (5.19). Banks with marginal costs above $\widetilde{MC}^{\mu^h}$ but below expected revenue $p_h r^*(Q_h^*)$ still specialize on high-risk loans. They can offer only small quantities, s.t. $e <$

$\beta_h q^*_{h,i}$. The cutoff marginal costs for these unconstrained banks in the high-risk market is defined as

$$\widetilde{MC}^h = p_h r^*(Q^*_h) \ . \tag{5.27}$$

The Basel III equilibrium is illustrated in the lower half of Figure 5.2 and is summarized in the following proposition.

Proposition 3. *With additive risk-weighted capital requirements and a leverage ratio, if Eq.* (5.17) *holds and*

$$\frac{\beta(\beta_h-\beta_l)}{\beta_h(\beta_h-\beta)}\left(\beta_l p_h r_h(Q*_h) - \beta_h p_l r_l(Q*_l)\right) + \frac{\beta_l(\beta-\beta_l)}{\beta_h(\beta_h-\beta)} p_h r'_h(Q^*_h)e < p_l r'_l(Q^*_l)e \tag{5.28}$$

$$-\beta_h\left(p_h r_h(Q^*_h) - p_l r_l(Q*_l)\right) < p_h r'_h(Q^*_h)e < -\beta\left(p_h r_h(Q*_h) - p_l r_l(Q*_l)\right) \tag{5.29}$$

more productive banks hold a mixed portfolio while less productive banks specialize on high-risk loans, i.e. optimal strategies in equilibrium are

$$(q^*_{h,i}, q^*_{l,i}, \mu^*_i, \lambda^*_i) = \begin{cases} (q^v_h, q^v_l, \mu^v_i, \lambda^v_i(MC_i)) & \text{if} \quad MC_i \leq \widetilde{MC}^l \\ \left(q^h, 0, \mu^h_i(MC_i), 0\right) & \text{if} \quad \widetilde{MC}^l < MC_i \leq \widetilde{MC}^{\mu^h} \\ \left(q^{uc}_{h,i}(MC_i), 0, 0, 0\right) & \text{if} \quad \widetilde{MC}^{\mu^h} < MC_i \leq \widetilde{MC}^h \\ (0,0,0,0) & \text{if} \quad \widetilde{MC}^h < MC_i \end{cases} \tag{5.30}$$

where a subset $\{1, \ldots, \nu_l\}$ *of banks with* $MC_i \leq \widetilde{MC}^l$ *for all* $i \in \{1, \ldots, \nu_l\}$ *offer an aggregate supply* Q^*_l *of low-risk loans at interest rate* $r^*_l(Q^*_l)$*, and a subset* $\{1, \ldots, \nu_h\}$ *of banks with* $MC_i \leq \widetilde{MC}^h$ *for all* $i \in \{1, \ldots, \nu_h\}$ *offer aggregate supply* Q^*_h *of high-risk loans at interest rate* $r^*_h(Q^*_h)$*.*

Proof. Proof is in the appendix. □

Note that the cutoffs defined above are only formally the same as in Eq. (5.16), (5.19), and (5.18). Because the interest rates in both equilibria are not necessarily the same, the values of these cutoffs differ between the Basel II and Basel III equilibrium. In fact, the number of banks in the low-risk market can only increase and therefore the number of active banks in the high-risk market increases as well.

Corollary 1. Comparing the portfolio choices in the Basel II and Basel III equilibrium, the cutoffs for marginal costs increase, i.e.

$$\widetilde{MC^l}^{BaselII} < \widetilde{MC^l}^{BaselIII} \tag{5.31}$$

and

$$\widetilde{MC^h} = p_h r_h(Q_h^{*BaselII}) < p_h r_h(Q_h^{*BaselIII}) \ . \tag{5.32}$$

Proof. Proof is in the appendix. □

Lemma 2. *By tightening capital requirements through the introduction of the leverage ratio, aggregate loan supply decreases and interest rates increase in both markets.*

Proof. Follows directly from Corollary 1. □

The results of Corollary 1 are illustrated in Figure 5.2. Taking the order of N banks according to their marginal costs, I distinguish six groups of banks according to whether they are affected or unaffected by the leverage ratio (i.e. whether they change their strategies between the Basel II and Basel III equilibrium) and whether they are constrained or unconstrained: (i - solid line segment) low-risk market incumbents, (ii - dashed) affected constrained high-risk market incumbents, (iii - solid) unaffected constrained high-risk market incumbents, (iv - dashdotted) affected unconstrained high-risk market incumbents, (v - solid) unaffected unconstrained high-risk market incumbents, and (vi - dotted) new entrants.

The most productive banks are the low-risk market incumbents (i). Their business model is affected directly by the leverage ratio. They react by shifting their portfolio and choosing the mixed strategy v. Thereby they reduce their supply of low-risk loans in order to compensate the additional cost of being constrained with higher loan rates which are available in the high-risk market. This in turn makes the low-risk market attractive for less productive banks that shift from a specialized high-risk into a mixed portfolio strategy (ii). The high-risk market gets more competitive as more productive banks enter it. In a Cournot-equilibrium with asymmetric costs, an increase in the number of banks in a market implies that supply is reduced and prices increase. This phenomenon is termed "anti-competitive" behavior by Amir and Lambson (2000).[10] Some specialized banks in the high-risk market are unaffected by the leverage ratio and do not change their strategy (iii), although they profit from the increase in the high-risk interest rate. Formerly unconstrained banks are able to increase their supply of loans so that some of them grow to point where they are constrained by the risk-weighted ratio (iv) and others grow as well but less (v). Finally, since expected revenue in the high-risk market is higher in the new equilibrium, new banks enter the high-risk market (vi). As a result, market shares are reallocated between heterogeneous banks. More productive banks lose market shares in their home market but gain shares in the other market. Less productive high-risk markets incumbents lose market shares.

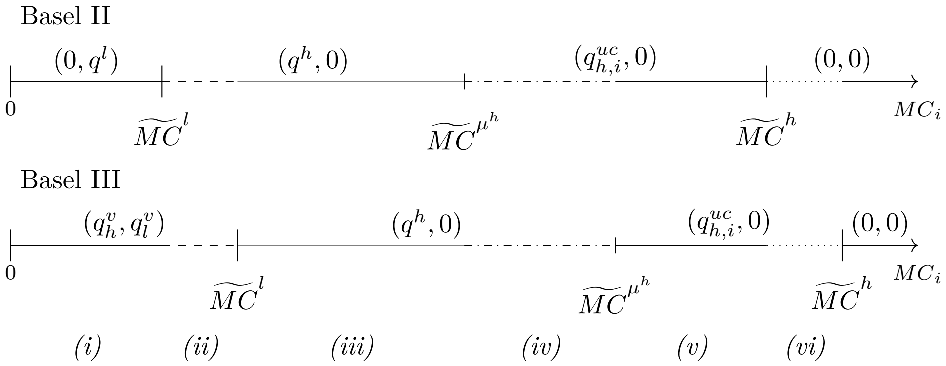
Lemma 3. *By tightening capital requirements through the introduction of a leverage ratio, market shares in the low-risk market are reallocated towards less productive banks while market shares in the high-risk market are reallocated towards more productive banks and less productive new entrants.*

Proof. Proof follows directly from proposition 3 and corollary 1. □

The reallocation of market shares in the low-risk market implies that the average productivity of banks participating in that market decreases. On the other hand average productivity in the high-risk market might increase, i.e. if the number of new entrants is relatively small. In the unregulated equilibrium, the most productive banks dominate both markets. Hence, any capital requirement indirectly protects market shares of less productive

[10] To rationalize this, consider that the competitive outcome is achievable in this model if the most productive bank 1 chooses to push every other bank out of the market by producing very high quantities at its marginal costs. Therefore, the more banks are active in equilibrium, the closer market outcomes are to monopoly outcomes. See sec. 5.5 for a discussion on how crucial the Cournot market is for the results.

FIGURE 5.2: Optimal strategies and cutoff marginal costs in both equilibria.



Notes: This figure shows optimal strategies and cutoff marginal costs in the Basel II equilibrium (upper line) and the Basel III equilibrium (lower line). Roman numbers on the bottom indicate groups of banks according to their change in strategy from the Basel II to Basel III equilibrium. Optimal strategies are: specialization on low-risk loans $(0, q^l)$, specialization on high-risk loans $(q^h, 0)$, vertex-strategy with a mixed portfolio (q^v_h, q^v_l), unconstrained specialization on high-risk loans $(q^{uc}_{h,i}, 0)$, or non-participation $(0, 0)$. The cutoffs with superscript (l) denote the marginal cost of the bank with the lowest productivity still offering low-risk loans, the cutoffs with superscript (h) denote the marginal cost of the bank with the lowest productivity still offering high-risk loans, and cutoffs with superscript (μ^h) denote the marginal cost of the bank with the lowest productivity still constrained by capital requirements.

banks in the affected market. This is of course even more visible when considering regulations which directly pose entry barriers to the banking market. The model shows that productivity advantages in an oligopolistic market add to the charter value of a bank which protects against individual failure in any kind of systemic crisis. A regulator concerned with financial stability should therefore take these side-effects on the distribution of market shares into account.

In terms of solvency, the effect of the leverage ratio differs between the categories defined above. First of all, new entrants (vi) have rather low critical values $z_{i,crit}$ because they focus on the high-risk market and their charter values are rather low, since they are closest to producing at marginal costs with zero profits. Unaffected constrained high-risk market incumbents (iii) neither change their portfolio nor their size but benefit from the rise of the interest rate. Therefore, their critical values increase which means that they become more resilient. Unconstrained high-risk market incumbents (iv,v) benefit from the rise of the high-risk interest rate as well. But these banks grow and have higher leverage ratios in the new equilibrium. In contrast to the other groups, banks with higher productivity (i,ii) change their portfolio composition in the new equilibrium. The direction in which the portfolio allocation channel takes effect depends on the realization of systematic risk. Banks with the highest productivity (i) increase their share of high-risk loans. For realizations of systematic risk below a threshold (defined in the appendix in Eq. (5.97)) this decreases their probability to default because of the positive effect of higher earnings from the high-risk market on their charter values. I term this *normal times*. When systematic risk realizes above the threshold, termed as *crisis*, the fraction of defaulting loans in the high-risk market gets prohibitively high so that the diversification in the mixed portfolio strategy turns out to have a negative effect on banks' resilience. For affected constrained high-risk market incumbents (ii) the reverse holds: In normal times their higher share of low-risk loans, which yield only low revenue, increases their default probabilities while in times of crisis the share of low-risk loans decreases their default probabilities.

Lemma 4. *Default probabilities of the most productive banks (affected low-risk market incumbents) decrease in normal times. In times of high realizations of systematic risk, the portfolio reallocation of these banks has a negative effect on their default probabilities.*

Default probabilities of less productive constrained banks (unaffected high-risk market incumbents) decrease. Default probabilities of affected high-risk market incumbents may increase due to increasing interest rates or decrease due to their portfolio reallocation and higher leverage. In times of high realizations of systematic risk, the portfolio reallocation of these banks has a positive effect on their default probabilities.

Proof. Formal proof is in the appendix. □

5.5 Discussion

The model highlights how regulation naturally interferes with regular market forces and thus creates side effects on financial stability. Productivity –irregardless of whether it stems from advantages in technology or information– influences banks' strategies and price setting. And ultimately, it influences market structure.

Regulators face a trade-off between assuring safety in the banking system and distorting competition. Banks should internalize risk-taking which is defined in various dimensions. Banks have different exposures to these dimensions. The model shows that these differences arise systematically due to the heterogeneity between banks. Therefore, as the regulator aims at confining risky banks it might as well narrow profitability of productive banks. Although unpleasant for a bank on its own, it can be seen as an exchange of intangible charter value into observable regulatory capital, both of which have a loss absorbing function.

A limitation to the model surely is the assumption that equity is fixed and the same amount for all banks. This serves to make banks comparable at some level. When in fact, productivity advantages and intangible charter value should be priced on the equity market in a way that more productive banks find it easier to refinance themselves. Increasing equity is an alternative strategy to risk-shifting as a reaction to the leverage ratio. Indeed, banks raised equity ever since the ratio was announced and monitored (Basel Committee on Banking Supervision, 2016; Smith et al., 2017) but investors should have been aware that the capital was needed to comply to tightened regulatory guidelines. However, for this model it would mean that the problem for more productive banks is just moving from the product to the equity market. Loosening constraints by raising equity allows banks to move closer to an unregulated equilibrium where productivity sponsors market shares and size. Consequently, if a leverage ratio were to be binding for any bank at all, it still were binding for the more productive banks even if they do not change their portfolio composition as a response.

Another critical assumption is Cournot competition. While it plausibly implies that productivity produces market power in the form of market shares and profits, it implies that lower concentration comes along with less competitive outcomes. Therefore, the set-up of the model is related to Efficient Structure theories. Such a relation between concentration and loan rates is confirmed by some studies (Jayaratne and Strahan, 1998), yet it is challenged by as many (cf. VanHoose (2007) for a comprehensive literature review).

The focus of my work lies on the evaluation of capital requirements. In this light, you may note that the positive effect on less productive high-risk market incumbents' default probabilities hinges on exactly this anti-competitive behavior. In other settings, if banks had some price setting power –irrespective of the question of entry and exit– it is reasonable if they reacted by passing on costs to costumers by increasing loan rates. As long as excessive risk-taking is associated with high quantities, the regulator cannot avoid increasing financial stability at the expense of credit rationing.

In a competitive setting where banks cannot influence market loan rates, less productive banks would exit the market if new regulation causes additional costs. In fact, this is what happens when moving from the unregulated equilibrium to the Basel II equilibrium. But since banks are already constrained when the leverage ratio is introduced, they can circumvent incurring the costs of being regulated by adapting their business model and entering the high-risk market.

5.6 Conclusion

My work studies the optimal portfolio choice under competing capital requirements for heterogeneous banks. It points to the fact that productivity differences might influence banks' exposures to risk systematically so that regulation indirectly affects certain types of banks. Capital requirements therefore have repercussions on market structure.

The model shows that if bank size is taxed by the newly introduced leverage ratio, then banks with high productivity are directly affected and react with risk-shifting. However, this higher share of high-risk loans does not increase their default probabilities, at least not as long as systematic risk is moderate. It induces a reallocation of market shares from more to less productive banks in the low-risk market. Average productivity in the low-risk market falls. These could be viewed as possible side effects of the current regulation. On the other hand, market shares in the high-risk market are distributed among a higher number of banks, including banks with high productivity. Compared to the Basel II equilibrium where high-risk loans are concentrated on low-productivity banks, this dispersion could be an unintended benefit of the new framework.

As the regulatory toolbox is filling up, it is important to consider the differential treatment caused by the interplay of different measures. The results could apply to other measures. For example, capital requirements on operational risk charge banks based on their gross income. While gross income is used as a proxy of risk caused by complexity, it is reasonable to assume that gross income depends on productivity as well. Productivity is hard to measure. Yet it can create positive charter value in an imperfect competitive environment. Since it might be a difficult to impossible task to formulate any requirements contingent on productivity in order to regulate heterogeneous banks, capital regulation should at least contemplate possible channels between productivity and risk. If risk measures are positively correlated to productivity measures, regulating these risks turns intangible charter value into observable capital. Generally, the banking market would be more transparent but not necessarily safer and market shares might be reshuffled. If on the other hand risk measures are negatively correlated to productivity, regulating these risks is more than called for. By using approaches with heterogeneous instead of representative banks, further theoretical work could systematically address the complex relationship between risk, capital, and productivity.

Appendix D

D.I Proof of Proposition 1

Before I start the proof of the characteristics of any equilibrium in the following, let me state that they indeed exist.

Lemma 5 (Existence of equilibria)**.** *The unregulated game, the game with a risk-weighted regulation, and the game with a leverage ratio and risk-weighted regulation have at least one Nash-equilibrium in pure strategies.*

Proof. Proof in appendix D.II. □

Proof. The First-order conditions to the optimization problem given in Eq. (5.8) for bank i are

$$\frac{\partial \Pi_i}{\partial q_{i,h}} \leq 0 \qquad \textit{and} \qquad \frac{\partial \Pi_i}{\partial q_{i,l}} \leq 0\ , \tag{5.33}$$

$$q_{i,h}\,\frac{\partial \Pi_i}{\partial q_{i,h}} = 0 \qquad \textit{and} \qquad q_{i,l}\,\frac{\partial \Pi_i}{\partial q_{i,l}} = 0 \tag{5.34}$$

where $\frac{\partial \Pi_i}{\partial q_{i,\eta}} = p_\eta(r_\eta(Q_\eta) + r'_\eta(Q_\eta)q_{i,\eta}) - MC_i$. From Eq. (5.34) and the non-negativity constraint on quantities, we know that banks either produce nothing or, if they supply a positive amount of loans, marginal profits must be zero. Further, if $MC_i > p_\eta r_\eta(Q_\eta)$ for any bank i given the strategies of all other banks , i.e. it cannot make a profit in the market at the given interest rate because its marginal costs are too high, then its marginal profits are negative for any non-negative amount of loans in that market. Note that

$$MC_i > p_\eta r_\eta(Q_\eta) > p_\eta r_\eta(Q_\eta) + p_\eta r'_\eta(Q_\eta)q_{i,\eta} \quad \forall\ q_{i,\eta} \geq 0\ . \tag{5.35}$$

Therefore, the best strategy for such a bank is to not participate.

There are two markets to cater to, so banks decide on their participation and the extend of it in both markets. They do this separately, since the extend to which they choose to produce in one market does not affect their actions or the actions of other banks in the other market. As a result, there can be three types of banks: First, banks that participate in both markets because their marginal costs are lower than both expected returns. Second, banks that participate only in the high-risk market, because their marginal costs are lower than expected return in the high-risk market but higher than expected return in the low-risk market. And third, banks that cannot participate in any market.[11]

Solving Eq. (5.33) for $q_{\eta,i}$, we get the best response function for bank i as

$$\hat{q}_i(Q_{-i}) = \begin{cases} (\hat{q}_{h,i}, \hat{q}_{l,i}) & \text{if } MC_i \leq p_l r_l(Q_l) \\ (\hat{q}_{h,i}, 0) & \text{if } p_l r_l(Q_l) < MC_i \leq p_h r_h \\ (0,0) & \text{if } p_h r_h(Q_h) < MC_i \end{cases}$$
$$\textit{where} \qquad \hat{q}_{\eta,i} = \frac{p_\eta r_\eta(q_{\eta,i}, Q_{\eta,-i}) - MC_i}{-p_\eta r'_\eta(q_{\eta,i}, Q_{\eta,-i})}\ . \tag{5.36}$$

[11] Note that $p_h r_h(Q_h) > p_l r_l(Q_l)$ by assumption.

Summing the FOCs for marginal profits in Eq. (5.33) over all banks gives

$$\begin{aligned} p_h(\, N r_h(Q_h) + r_h'(Q_h) Q_h\,) - \sum_{i=1}^{N} MC_i \leq 0 \\ p_l(\, N r_l(Q_l) + r_l'(Q_l) Q_l\,) - \sum_{i=1}^{N} MC_i \leq 0 \,. \end{aligned} \tag{5.37}$$

Let ν_h denote the bank with the highest marginal costs that is still able to supply high-risk loans at a profit and let ν_l denote the bank with the highest marginal costs that is still able to supply low-risk loans. We can rewrite Eq. (5.37) as

$$\begin{aligned} p_h(\, \nu_h r_h(Q_h) + r_h'(Q_h) Q_h\,) - \sum_{i=1}^{\nu_h} MC_i = 0 \\ p_l(\, \nu_l r_l(Q_l) + r_l'(Q_l) Q_l\,) - \sum_{i=1}^{\nu_l} MC_i = 0 \,. \end{aligned} \tag{5.38}$$

Solving Eq. (5.38) for the first derivative of the inverse demand function and inserting this into the best response function, we get

$$\hat{q}_{\eta,i}(Q_\eta) = \frac{p_\eta r_\eta(Q_\eta) - MC_i}{\nu_\eta p_\eta r_\eta(Q_\eta) - \sum_{i=1}^{\nu_\eta} MC_i} Q_\eta \,. \tag{5.39}$$

From Lemma 5 we know an equilibrium must exist. An equilibrium is characterized by best-response correspondence such that

$$q_i^* = \arg\max \Pi_i(q_i, Q_{-i}^*) \quad \forall i \in \{1, \dots, N\} \,. \tag{5.40}$$

Hence, if there is an equilibrium, optimal strategies of banks must be defined as

$$\begin{aligned} q_i^* &= (q_{h,i}^*, q_{l,i}^*) \quad \text{with} \\ q_{h,i}^* &= \max\left[0, \frac{p_h r_h(Q_h^*) - MC_i}{\nu_h p_h r_h(Q_h^*) - \sum_{i=1}^{\nu_h} MC_i} Q_h^*\right] \\ q_{l,i}^* &= \max\left[0, \frac{p_\eta r_l(Q_l^*) - MC_i}{\nu_l a p_l r_l(Q_l^*) - \sum_{i=1}^{\nu_l} MC_i} Q_l^*\right] \,. \end{aligned} \tag{5.41}$$

Corollary 2 (Market shares without capital requirements)**.** In the unregulated equilibrium, more productive banks, i.e. banks with lower marginal costs, gain higher market shares than less productive banks.

Proof. Let $\kappa_{\eta,i} = (q_{\eta,i}/Q_\eta)$ denote the market share of bank i in market η. Then

$$\begin{gathered} \kappa_{\eta,i} > \kappa_{\eta,i+1} \\ \frac{p_\eta r_\eta(Q_\eta) - MC_i}{-p_\eta r_\eta'(Q_\eta)} > \frac{p_\eta r_\eta(Q_\eta) - MC_{i+1}}{-p_\eta r_\eta'(Q_\eta)} \\ MC_i < MC_{i+1} \end{gathered} \tag{5.42}$$

holds in both markets. □

Corollary 3 (Bank size without capital requirements)**.** In the unregulated equilibrium, more productive banks are bigger than less productive banks.

Proof. See that

$$\begin{aligned} q^*_{h,i} + q^*_{l,i} &> q^*_{h,i+1} + q^*_{l,i+1} \\ \kappa_{h,i} Q^*_h + \kappa_{l,i} Q^*_l &> \kappa_{h,i+1} Q^*_h + \kappa_{l,i+1} Q^*_l \\ (\kappa_{h,i} - \kappa_{h,i+1}) Q^*_h &> (\kappa_{l,i+1} - \kappa_{l,i}) Q^*_l \end{aligned} \tag{5.43}$$

is always true, because the left-hand side of the last inequality is positive while the right-hand side is always negative due to Corollary 2. □

Corollary 4 (Portfolio shares without capital requirements)**.** In the unregulated equilibrium, more productive banks have a higher share of riskier loans in their portfolio than less productive banks.

Proof. Let $\gamma_i = \frac{q_{h,i}}{q_{h,i}+q_{l,i}}$ denote the share of high-risk loans to total loans of bank i. Then

$$\begin{aligned} \gamma_i &< \gamma_{i+1} \\ \frac{q^*_{h,i}}{q^*_{h,i+1}} &< \frac{q^*_{l,i}}{q^*_{l,i+1}} \\ MC_i &< MC_{i+1} \; . \end{aligned} \tag{5.44}$$

□

□

D.II Proof of Lemma 5

Proof. This proof applies the results of Vives (2001b) and checks whether the conditions formulated therein are met in all games. According to Vives (2001b) Theorem 2.1, a Nash equilibrium for a game with strategy set Ω_i, payoffs Π_i, and players $i \in \{1, \ldots, N\}$ exists, if

a) strategy sets Ω_i are non-empty, convex, and compact subsets of Euclidean space, and

b) payoff Π_i is continuous in the actions of all firms and

c) quasi-concave in its own action.

a) The strategy set of bank i consists of all possible quantities of loans. The model facilitates the view of a bank to a simple loan generating and deposit taking intermediary and therefore abstracts from other financial products where negative positions would be attainable. A potential strategy is therefore non-negative and the strategy set focuses on the upper right quadrant of $\mathbb{R}^2$ which is a non-empty convex set and subset of Euclidean space. Since zero is included in the strategy set, it is closed. Given a capacity limit $0 \leq q_i \leq W_i$, the set is bounded. The Heine-Borel theorem states that any bounded and closed subset of Euclidean space is also compact. Consequently, the first condition is met by an unregulated market.

The capital requirements essentially lower the upper bound on the strategy set. Both constraints are linear and define a triangle in $\mathbb{R}^2$, which is convex. Figure 5.1 illustrates both constraints. In the case of joint regulation with both constraints, the strategy set is an intersection of the two strategy sets of the preceding games which are both convex. Hence, their intersection is convex as well. In all constrained cases, they include the upper bound and zero as the lower bound. Consequently, strategy sets of the constrained games are non-empty, convex, and compact subsets of Euclidean space. Let the strategy set Ω_i be defined as

$$
\begin{array}{ll}
\textit{(without constraints)} & \Omega_i = \{q_i \mid 0 \leq q_i \leq W_i\} \\
\textit{(risk-weighted)} & \Omega_i = \{q_i \mid 0 \leq \beta_h q_{h,i} + \beta_l q_{l,i} \leq e\} \\
\textit{(both constraints)} & \Omega_i = \{q_i \mid 0 \leq \max\left[\beta_h q_{h,i} + \beta_l q_{l,i}, \beta(q_{h,i} + q_{l,i})\right] \leq e\}
\end{array}
$$

b) The payoff function of bank i is given as

$$\Pi_i(q_i) = (p_h r_h(Q_h) - MC_i)q_{h,i} + (p_l r_l(Q_l) - MC_i)q_{l,i}$$

where continuity follows from the continuity of its components. The inverse demand functions in $r(Q)$ are continuous by definition and q_i itself is continuous. Hence their product and difference is. Adding constraints was shown to alter the strategy space but not the payoff function. Therefore, the second condition for the existence of an equilibrium is fulfilled in all scenarios.

c) Profits are quasi-concave with respect to banks' own strategy choices, if all principal minors of the bordered Hessian matrix of $\Pi_i(q_i)$ are of alternating signs. Bordered Hessian of $\Pi(q_i)$ holding Q_{-i} constant is

$$H = \begin{pmatrix} 0 & \frac{\partial \Pi_i}{\partial q_{i,l}} & \frac{\partial \Pi_i}{\partial q_{i,h}} \\ \frac{\partial \Pi_i}{\partial q_{i,l}} & \frac{\partial^2 \Pi_i}{\partial q_{i,l}^2} & 0 \\ \frac{\partial \Pi_i}{\partial q_{i,h}} & 0 & \frac{\partial^2 \Pi_i}{\partial q_{i,h}^2} \end{pmatrix} .$$

The first principal minor is

$$-\left(\frac{\partial \Pi_i}{\partial q_{i,l}}\right)^2 \leq 0 ,$$

which is non-positive by construction of H. The second principal minor is equal to the determinant of H which is

$$-\frac{\partial^2 \Pi_i}{\partial q_{i,l}^2}\left(\frac{\partial \Pi_i}{\partial q_{i,h}}\right)^2 - \frac{\partial^2 \Pi_i}{\partial q_{i,h}^2}\left(\frac{\partial \Pi_i}{\partial q_{i,l}}\right)^2 \geq 0 .$$

This is non-negative since

$$\frac{\partial^2 \Pi_i}{\partial q_{i,\eta}^2} = 2p_\eta \frac{\partial r_\eta}{\partial q_{i,\eta}} + p_\eta q_{i,\eta} \frac{\partial^2 r_\eta}{\partial q_{i,\eta}^2}$$

and inverse demand is concave so that $\frac{\partial r_\eta}{\partial q_{i,\eta}} < 0$ and $\frac{\partial^2 r_\eta}{\partial q_{i,\eta}^2} < 0$ (See assumption in Eq. (5.2)). Therefore, Π_i is quasi-concave with respect to q_i. Constraints on the strategy set in form of capital requirements do not alter the profit function, hence the third condition for existence is fulfilled in all scenarios. We conclude that at least one Nash-equilibrium must exist in each game. □

D.III Proof of Proposition 2

Proof. The proof is structured as follows. First, I compare all possible strategies to eliminate dominated strategies. Then, I derive the conditions for feasibility of the dominating strategies.

From the FOCs of Eq. (5.14) we derive five possible strategies depending on whether the risk-weighted constraint in Eq. (5.13) is binding. Let s denote the strategy where $s \in \{l, rw, h, uc, 0\}$, and $q^s_{\eta,i}$ the optimal quantity of bank i in market η , Π^s_i its payoff, and μ^s_i its slack parameters if it implements strategy s.

$$(q^s_{h,i}, q^s_{l,i}, \mu^s_i) = \begin{cases} (0, q^l_l, \mu^l_i) & \text{low-risk specialist} \\ (q^{rw}_{h,i}, q^{rw}_{l,i}, \mu^{rw}_i) & \text{mixed risk-weighted constrained} \\ (q^h_h, 0, \mu^h_i) & \text{high-risk specialist} \\ (q^{uc}_{h,i}, q^{uc}_{l,i}, 0) & \text{unconstrained} \\ (0, 0, 0) & \text{not participating} \end{cases} \tag{5.45}$$

where $q^{uc}_{\eta,i}$ is defined in Eq. (5.9), and $q^{rw}_{h,i}, q^{rw}_{l,i}, \mu^{rw}_i, \mu^l_i$,and μ^h_i depend on MC_i, r, and r', while q^l_l and q^h_h are independent of MC_i, and

$$q^l = \frac{e}{\beta_l}, \quad q^h = \frac{e}{\beta_h} \;. \tag{5.46}$$

If feasible, constrained strategies dominate the unconstrained strategy and clearly the non-participating strategy, since in the unconstrained strategy banks are left with unused equity. If no constrained strategy is feasible for a bank, but still marginal costs are lower than expected revenue from any loan (i.e. $MC_i \leq \widetilde{MC}^h$, see Eq. (5.18)), banks participate (see Eq. (5.35)) with an unconstrained strategy.

From Eq. (5.16) we know that banks with marginal costs below the cutoff prefer strategy l over h. Comparing l and rw gives

$$\begin{aligned} \Pi^{rw}_i(q^{rw}_i) &< \Pi^l_i(q^l) \\ (p_h r_h - MC_i)q^{rw}_{h,i} + (p_l r_l - MC_i)q^{rw}_{l,i} &< (p_l r_l - MC_i)q^l \\ \frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &< \frac{q^l - q^{rw}_{l,i}}{q^{rw}_{h,i}} \\ \frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &< \frac{\beta_h}{\beta_l} \end{aligned} \tag{5.47}$$

which is the same condition as in Eq. (5.15). For the last step, I used the fact that Eq. (5.13) holds with equality for strategy l and rw. Consequently, whenever strategy l dominates h, l dominates rw as well. One can show in a similar way, that whenever strategy h dominates l, it dominates rw as well. Hence, banks would never choose a mixed portfolio strategy if a specialization strategy is available.

Now, I derive conditions for feasibility of all strategies. First, the cutoff $\widetilde{MC}^l$ has to be positive. Otherwise all banks find it optimal to specialize on high-risk loans with can never be a Nash-equilibrium. Then supply of high-risk loans would be very high and the loan rate falls whereas there is no supply of low-risk loans so that the interest rate on low-risk loans rises and ultimately $p_h r_h > p_l r_l$ is violated or $\widetilde{MC}^l > 0$. The first condition is therefore

$$p_l r_l(Q_l^*) < p_h r_h(Q_h^*) < \tfrac{\beta_h}{\beta_l} p_l r_l(Q_l^*) \,. \tag{5.48}$$

Secondly, a strategy s is only feasible if $\mu_i^s \geq 0$. The shadow prices are functions of marginal costs and market prices ($\mu_i^s(MC_i, r(Q))$) which imply cutoffs $\widetilde{MC}^{\mu^s}$ which themselves have to be positive to be meaningful, s.t.

$$\mu_i^s \geq 0 \quad \forall i \in \{1,...,N\} : MC_i \leq \widetilde{MC}^{\mu^s} \quad \text{where} \quad \widetilde{MC}^{\mu^s} > 0 \tag{5.49}$$

For strategies l and h this means that

$$\mu_i^l \geq 0 \quad \forall i \in \{1,...,N\} : MC_i \leq \widetilde{MC}^{\mu^l} \text{ where } \widetilde{MC}^{\mu^l} = p_l r_l + \frac{e}{\beta_l} p_l r_l' > 0 \tag{5.50}$$

$$\mu_i^h \geq 0 \quad \forall i \in \{1,...,N\} : MC_i \leq \widetilde{MC}^{\mu^h} \text{ where } \widetilde{MC}^{\mu^h} = p_h r_h + \frac{e}{\beta_h} p_h r_h' > 0 \tag{5.51}$$

Thirdly, the following conditions ensure that there is a certain order between feasibility cutoffs $\widetilde{MC}^{\mu^s}$ and dominance cutoffs $\widetilde{MC}^l$ and $\widetilde{MC}^h$. All banks with $MC_i \leq \widetilde{MC}^l$ can choose l only if

$$\begin{gathered} \widetilde{MC}^l < \widetilde{MC}^{\mu^l} \\ -\frac{\beta_l}{\beta_h - \beta_l}(p_h r_h(Q_h^*) - p_l r_l(Q_l^*)) < \frac{e}{\beta_l} p_l r_l'(Q_l^*) < 0 \,. \end{gathered} \tag{5.52}$$

All banks with $MC_i \leq \widetilde{MC}^{\mu^h}$ can choose h only if

$$\begin{gathered} \widetilde{MC}^{\mu^{rw}} < \widetilde{MC}^{\mu^h} \\ (p_l r_l(Q_l^*) - p_h r_h(Q_h^*)) < \frac{e}{\beta_h} p_h r_h'(Q_h^*) < 0 \,. \end{gathered} \tag{5.53}$$

Eq. (5.53) usefully implies that

$$\begin{aligned} & p_l r_l(Q_l^*) < p_h r_h(Q_h^*) + \frac{e}{\beta_h} p_h r_h'(Q_h^*) \\ & p_l r_l(Q_l^*) < \widetilde{MC}^{\mu^h} \end{aligned} \tag{5.54}$$

so that if banks choose the unconstrained strategy, they specialize on high-risk loans and are not able to supply low-risk loans profitably.

Furthermore, condition (5.52) is always stricter than condition (5.50), and condition (5.53) is always stricter than condition (5.51). Hence, given Eq. (5.17),(5.52), and (5.53) optimal strategies in equilibrium are

$$
(q_{h,i}^*, q_{l,i}^*, \mu_i^*) = \begin{cases} \left(0, q_l^l, \mu_i^l(MC_i)\right) & \text{if} \quad MC_i \leq \widetilde{MC}^l \\ \left(q_h^h, 0, \mu_i^h(MC_i)\right) & \text{if} \quad \widetilde{MC}^l < MC_i \leq \widetilde{MC}^{\mu^h} \\ \left(q_{h,i}^{uc}(MC_i), 0, 0\right) & \text{if} \quad \widetilde{MC}^{\mu^h} < MC_i \leq \widetilde{MC}^h \end{cases} \tag{5.55}
$$

□

D.IV Proof of Lemma 1

Proof. First, I show that within each strategy, banks with lower marginal costs have higher critical values and therefore lower default probabilities. Then, I show that within the same bank and given $p_h r_h(Q_h^*) < \frac{\beta_h}{\beta_l} p_h r_l(Q_l^*)$, strategies with a higher share of high-risk loans have a higher default probability.

For the specialized strategies, we can solve Eq. (5.10) for $z_{i,crit}^\eta$ which is the critical value of bank i if it specializes on strategy η. Given equilibrium strategies and outcomes we get

$$
\begin{aligned}
\left(1 - PD_\eta(z_{i,crit}^\eta)\right) r_\eta(Q_\eta^*) q_\eta^{\eta*} - MC_i q^{\eta*} + r_d e &= 0 \\
\left(1 - \Phi\left(\frac{\zeta_\eta + \sqrt{\rho}\, z_{i,crit}^\eta}{\sqrt{1-\rho}}\right)\right) r_\eta(Q_\eta^*) \frac{e}{\beta_\eta} - MC_i \frac{e}{\beta_\eta} + r_d e &= 0\,.
\end{aligned} \tag{5.56}
$$

Rearranging gives

$$
z_{i,crit}^\eta = \frac{\sqrt{1-\rho}}{\sqrt{\rho}}\, \Phi^{-1}\left(1 - \frac{MC_i - r_d \frac{e}{q_\eta^{\eta*}}}{r_\eta(Q_\eta^*)}\right) - \frac{\zeta_\eta}{\sqrt{\rho}}\,. \tag{5.57}
$$

Except MC_i, all parameters in Eq. (5.57) are equal for banks with the same constrained equilibrium strategy. Taking the derivative with respect to MC_i gives

$$
\frac{\partial z_{i,crit}^\eta}{\partial MC_i} = (-1) \frac{\sqrt{1-\rho}}{\sqrt{\rho}\, \phi\left(\Phi^{-1}\left(1 - \frac{MC_i - r_d \frac{e}{q_\eta^{\eta*}}}{r_\eta(Q_\eta^*)}\right)\right)} < 0 \tag{5.58}
$$

where $\phi(x)$ is the PDF of the standard normal distribution. Therefore, if $MC_i < MC_{i+1}$, then $z_i^\eta > z_{i+1}^\eta$ for $\eta = \{h, l\}$.

For high-risk specialists that are not constrained (strategy uc), the parameters MC_i and q_h^{uc*} change in Eq. (5.57). Simplifying $z_{i,crit}^{uc} > z_{i+1,crit}^{uc}$ yields

$$
(MC_{i+1} - MC_i) q_{h,i+1}^{uc*} q_{h,i}^{uc*} > r_d e (q_{h,i+1}^{uc*} - q_{h,i}^{uc*}) \tag{5.59}
$$

which is always true since $q_{h,i+1}^{uc*} - q_{h,i}^{uc*} < 0$.
Hence, when comparing different banks with the same strategy, we find that within each market banks with lower marginal costs have higher critical values and therefore lower default probabilities.

Let us now compare default probabilities of different strategies for one bank i. If $p_h r_h(Q_h^*) < \frac{\beta_h}{\beta_l} p_h r_l(Q_l^*)$, then

$$1 - \frac{MC_i - r_d\beta_l}{r_l(Q_l^*)} > 1 - \frac{MC_i - r_d\beta_h}{r_h(Q_h^*)} \tag{5.60}$$

and hence

$$\Phi^{-1}\left(1 - \frac{MC_i - r_d\beta_l}{r_l(Q_l^*)}\right) > \Phi^{-1}\left(1 - \frac{MC_i - r_d\beta_h}{r_h(Q_h^*)}\right) \tag{5.61}$$

so that the right hand side in the following is negative which ensures that it is true that

$$\frac{\zeta_h - \zeta_l}{\sqrt{1-\rho}} > \Phi^{-1}\left(1 - \frac{MC_i - r_d\beta_h}{r_h(Q_h^*)}\right) - \Phi^{-1}\left(1 - \frac{MC_i - r_d\beta_l}{r_l(Q_l^*)}\right) \tag{5.62}$$

and thus

$$z_{i,crit}^l > z_{i,crit}^h \,. \tag{5.63}$$

Since we know that $z_{i,crit}^h > z_{i+1,crit}^h$, we can compare the default probabilities of the least productive bank in the low-risk market ν_l (which has marginal cost just below or at the cutoff: $MC_{\nu_l} \leq \widetilde{MC}^l$) with the next bank ν_{l+1} that is the most productive bank in the high-risk market with $MC_{\nu_l+1} > \widetilde{MC}^l$, and state that

$$z_{1,crit}^l > \cdots > z_{\nu_l,crit}^l > z_{\nu_l,crit}^h > z_{\nu_l+1,crit}^h > \cdots > z_{\nu_h,crit}^{uc} \,. \tag{5.64}$$

□

D.V Proof of Proposition 3

Proof. The proof is structured as follows. First, I compare all possible strategies to eliminate dominated strategies. Then, I derive conditions for feasibility of dominating strategies.

From the FOCs of Eq. (5.25) we can derive seven possible strategies depending on which or if any constraint is binding. Let s denote the strategy where $s \in \{l, lr, v, rw, h, uc, 0\}$, and $q_{\eta,i}^s$ the optimal quantity of bank i in market η , Π_i^s its payoff, and μ_i^s and λ_i^s its slack parameters if it implements strategy s.

$$(q_{h,i}^s, q_{l,i}^s, \mu_i^s, \lambda_i^s) = \begin{cases} (0, q_l^l, 0, \lambda_i^l) & \text{low-risk specialist} \\ (q_h^{lr}, q_l^{lr}, 0, \lambda_i^{lr}) & \text{mixed lr-constrained} \\ (q_h^v, q_l^v, \mu^v, \lambda_i^v) & \text{mixed lr- and rw-constrained} \\ (q_{h,i}^{rw}, q_{l,i}^{rw}, \mu_i^{rw}, 0) & \text{mixed rw-constrained} \\ (q_h^h, 0, \mu_i^h, 0) & \text{high-risk specialist} \\ (q_{h,i}^{uc}, q_{l,i}^{uc}, 0, 0) & \text{unconstrained} \\ (0,0,0,0) & \text{not participating} \end{cases} \tag{5.65}$$

where $q^{uc}_{\eta,i}$ is defined in Eq. (5.9), $q^{rw}_{h,i}, q^{rw}_{l,i}, \mu^s_i, \lambda^s_i$, and μ^h_i depend on MC_i, r, and r', while q^{lr}_h, q^{lr}_l are independent of MC_i and depend on r, and r', and

$$q^l_l = \frac{e}{\beta}\,, \quad q^h_h = \frac{e}{\beta_h}\,, \quad q^v_h = \frac{(\beta - \beta_l)e}{\beta(\beta_h - \beta_l)}\,, \quad q^v_l = \frac{(\beta_h - \beta)e}{\beta(\beta_h - \beta_l)}\,.$$

If feasible, banks choose constrained over the unconstrained or the non-participating strategy. If a bank is constrained by the leverage ratio in equilibrium, it has strong incentives to increase the share of high-risk loans as much as possible (Kim and Santomero, 1988). Comparing the payoff of strategies v and l gives

$$\begin{aligned}
\Pi^v_i(q^v) &> \Pi^l_i(q^l)\\
p_h r_h q^v_h + p_l r_l q^v_l - MC_i(q^v_h + q^v_l) &> p_l r_l q^l - MC_i q^l\\
p_h r_h q^v_h - p_l r_l (q^l_i - q^v_l) &> 0\\
(p_h r_h - p_l r_l) q^v_h &> 0\,.
\end{aligned} \tag{5.66}$$

Note that for all strategies constrained by the leverage ratio Eq. (5.24) holds with equality so that bank i's costs are equal for strategies l,lr, and v. Furthermore, since $q^l = \frac{e}{\beta}$, from Eq. (5.24) follows that $q^l - q^v_l = q^v_h$. Comparing the payoff of strategies v and lr gives

$$\begin{aligned}
\Pi^v_i(q^v) &> \Pi^{lr}_i(q^{lr})\\
p_h r_h q^v_h + p_l r_l q^v_l - MC_i(q^v_h + q^v_l) &> p_h r_h q^{lr}_h + p_l r_l q^{lr}_l - MC_i(q^{lr}_h + q^{lr}_l)\\
p_h r_h (q^v_h - q^{lr}_h) - p_l r_l (q^{lr}_l - q^v_l) &> 0\\
(p_h r_h - p_l r_l)(q^{lr}_h - q^v_h) &> 0
\end{aligned} \tag{5.67}$$

For the last step, reckon that the leverage ratio constraint in Eq. (5.24) holds with equality for strategies v and lr. Eq. (5.67) and Eq. (5.66) are true for all banks irregardless of MC_i. Hence, strategy v dominates strategies l and lr.

$$\begin{aligned}
\Pi^v_i(q^v) &> \Pi^l_i(q^l) \qquad \forall MC_i\\
\Pi^v_i(q^v) &> \Pi^{lr}_i(q^{lr}) \qquad \forall MC_i
\end{aligned} \tag{5.68}$$

Comparing strategy v to h gives the cutoff defined in Eq. (5.26), and comparing it to strategy rw gives

$$\begin{aligned}
\Pi^{rw}_i(q^{rw}_i) &< \Pi^v_i(q^v)\\
(p_h r_h - MC_i) q^{rw}_{h,i} + (p_l r_l - MC_i) q^{rw}_{l,i} &< (p_h r_h - MC_i) q^v_h + (p_l r_l - MC_i) q^v_l\\
\frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &< \frac{q^v_l - q^{rw}_{l,i}}{q^{rw}_{h,i} - q^v_h}\\
\frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &< \frac{\beta_h}{\beta_l}
\end{aligned} \tag{5.69}$$

which gives the same cutoff as in Eq. (5.26). For the last step, note that Eq. (5.13) holds with equality for both strategies. Hence, strategy v only dominates strategies h and rw if marginal costs are below the cutoff, i.e.

$$\begin{aligned} \Pi_i^v(q^v) &> \Pi_i^h(q^h) \qquad \forall MC_i : MC_i \leq \widetilde{MC}^l \\ \Pi_i^v(q^v) &> \Pi_i^{rw}(q^{rw}) \qquad \forall MC_i : MC_i \leq \widetilde{MC}^l \end{aligned} \tag{5.70}$$

Comparing strategies h and rw gives

$$\begin{aligned} \Pi_i^{rw}(q_i^{rw}) &< \Pi_i^h(q^h) \\ (p_h r_h - MC_i)q_{h,i}^{rw} + (p_l r_l - MC_i)q_{l,i}^{rw} &< (p_h r_h - MC_i)q_h^h \\ \frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &> \frac{q_{l,i}^{rw}}{q_{h,i}^{rw} - q_h^h} \\ \frac{(p_h r_h - MC_i)}{(p_l r_l - MC_i)} &> \frac{\beta_h}{\beta_l} \end{aligned} \tag{5.71}$$

which again gives the same cutoff as in Eq. (5.26). Hence,

$$\begin{aligned} \Pi_i^h(q^h) &> \Pi_i^{rw}(q_i^{rw}) \qquad \forall i \in \{1, ..., N\} : MC_i > \widetilde{MC}^l \\ \Pi_i^h(q^h) &> \Pi_i^v(q_i^v) \qquad \forall i \in \{1, ..., N\} : MC_i > \widetilde{MC}^l . \end{aligned} \tag{5.72}$$

Now, I derive conditions for feasibility of all strategies. Firstly, we need condition (5.17) to ensure that the cutoff $\widetilde{MC}^l$ separating strategy v and h is positive.

Secondly, a strategy s is only feasible if $\mu_i^s \geq 0$ and $\lambda_i^s \geq 0$. Some shadow prices are functions of marginal costs and market prices ($\mu_i^s(MC_i, r(Q))$ or $\lambda_i^s(MC_i, r(Q))$) which imply cutoffs $\widetilde{MC}^{\mu^s}$ or $\widetilde{MC}^{\lambda^s}$ which themselves have to be positive to be meaningful, s.t.

$$\mu_i^s \geq 0 \quad \forall i \in \{1, ..., N\} : MC_i \leq \widetilde{MC}^{\mu^s} \quad \text{where} \quad \widetilde{MC}^{\mu^s} > 0 \tag{5.73}$$

For strategies v and h this means

$$\mu_i^h \geq 0 \; \forall i \in \{1, ..., N\} : MC_i \leq \widetilde{MC}^{\mu^h} \text{ where } \widetilde{MC}^{\mu^h} > 0 \tag{5.74}$$

$$\lambda_i^v \geq 0 \; \forall i \in \{1, ..., N\} : MC_i \leq \widetilde{MC}^{\lambda^v} \text{ where } \widetilde{MC}^{\lambda^v} > 0 \tag{5.75}$$

$$\mu^v \geq 0 \; \forall i \in \{1, ..., N\} \tag{5.76}$$

where

$$\widetilde{MC}^{\mu^h} = p_h r_h + \frac{e}{\beta_h} p_h r_h' \tag{5.77}$$

$$\widetilde{MC}^{\lambda^v} = \frac{\beta_h p_l r_l - \beta_l p_h r_h}{(\beta_h - \beta_l)} + \frac{\beta_h(\beta_h - \beta)}{\beta(\beta_h - \beta_l)^2} p_l r_l' e - \frac{\beta_l(\beta - \beta_l)}{\beta(\beta_h - \beta_l)^2} p_h r_h' e \tag{5.78}$$

$$\mu^v = \frac{p_h r_h - p_l r_l}{(\beta_h - \beta_l)} - \frac{(\beta_h - \beta)}{\beta(\beta_h - \beta_l)^2} p_l r_l' e + \frac{(\beta - \beta_l)}{\beta(\beta_h - \beta_l)^2} p_h r_h' e \tag{5.79}$$

Thirdly, strategies v and h should be viable for all banks for whom these strategies are profit maximizing. That is the case if

$$\widetilde{MC}^{l} < \widetilde{MC}^{\lambda^v} < \widetilde{MC}^{\mu^h} \tag{5.80}$$

$$\widetilde{MC}^{\mu^h} > \max\left[\widetilde{MC}^{\mu^{rw}}, \widetilde{MC}^{\lambda^l}, \widetilde{MC}^{\lambda^{lr}}, p_l r_l\right] . \tag{5.81}$$

where

$$\widetilde{MC}^{\mu^{rw}} = \tag{5.82}$$

$$\widetilde{MC}^{\lambda^l} = \tag{5.83}$$

$$\widetilde{MC}^{\lambda^{lr}} = \tag{5.84}$$

The conditions given in Eq. (5.74), (5.75), (5.76), (5.80), and (5.81) simplify to Eq. (5.28) and (5.29) in the following way: Given (5.74) and (5.75), $\widetilde{MC}^{l} < \widetilde{MC}^{\lambda^v}$ in (5.80) is true. Given $\widetilde{MC}^{\lambda^v} < \widetilde{MC}^{\mu^h}$ in (5.80), (5.74) is true. If (5.75) and

$$-\beta_h(p_h r_h - p_l r_l) < p_h r'_h e \,, \tag{5.85}$$

then $\widetilde{MC}^{\mu^h} > p_l r_l$ in (5.81) which itself implies $\widetilde{MC}^{\mu^h} > \widetilde{MC}^{\lambda^l}$, and $\widetilde{MC}^{\mu^h} > \widetilde{MC}^{\mu^{rw}}$ in (5.81). If (5.85) and

$$p_h r'_h e < -\beta(p_h r_h - p_l r_l) \,, \tag{5.86}$$

then $\widetilde{MC}^{\mu^h} > \widetilde{MC}^{\lambda^{lr}}$ in (5.81). To sum up, condition (5.28) is equal to Eq. (5.75), and Eq. (5.85) and (5.86) combine to condition (5.29) which is stricter than (5.76) and $\widetilde{MC}^{\lambda^v} < \widetilde{MC}^{\mu^h}$ in (5.80).

Hence, given Eq. (5.75), (5.85), and (5.86) optimal strategies in equilibrium are

$$(q^*_{h,i}, q^*_{l,i}, \mu^*_i, \lambda^*_i) = \begin{cases} (q^v_h, q^v_l, \mu^v_i, \lambda^v_i(MC_i)) & \text{if} \quad MC_i \leq \widetilde{MC}^{l} \\ \left(q^h, 0, \mu^h_i(MC_i), 0\right) & \text{if} \quad \widetilde{MC}^{l} < MC_i \leq \widetilde{MC}^{\mu^h} \\ \left(q^{uc}_{h,i}(MC_i), 0, 0, 0\right) & \text{if} \quad \widetilde{MC}^{\mu^h} < MC_i \leq \widetilde{MC}^{h} \end{cases} \tag{5.87}$$

□

D.VI Proof of Corollary 1

Proof. I proof Corollary 1 by contradiction. Assume the cutoff $\widetilde{MC}^{l}$ decreases. It implies that the number of banks participating in low-risk market decreases. Then fewer banks produce a smaller quantity each so that the total supply of low-risk loans decreases. Note that these banks previously produced $q^l_l = \frac{e}{\beta_l}$ and now produce $q^v_l = \frac{(\beta_h - \beta)e}{\beta(\beta_h - \beta_l)} < q^l_l$. Hence, the interest rate on low-risk loans increases. From Eq. (5.26) follows that the interest rate on high-risk loans must increase as well (and even more) otherwise the cutoff would not decrease as was assumed.

Due to Eq. (5.2) the interest rate on high-risk loans only increases if total supply decreases. On the other hand an increase of r_h implies that the cutoffs $\widetilde{MC^h}$ and $\widetilde{MC^{\mu_h}}$ both increase while $\widetilde{MC^l}$ decreases. Thus, the number of specialized banks in the high-risk market increases and more productive banks with strategy v enter the high-risk market. All in all, this implies that the aggregate supply of high-risk loans must increase which contradicts the necessary decrease of aggregate supply such that the interest rate could rise. Hence, the cutoff $\widetilde{MC^l}$ cannot decrease but has to increase.

Assume further the cutoff $\widetilde{MC^h}$ decreases. Then the interest rate on high-risk loans necessarily decreases and aggregate supply increases. That is

$$\begin{gathered} Q_h^{*B2} < Q_h^{*B3} \\ \nu_l^{B3}(1+\frac{q_h^v}{q_h^h}) - \nu_l^{B2} < (\nu_h^{B3} - \nu_h^{B2}) \end{gathered} \tag{5.88}$$

which cannot be true since the right hand side is negative if the cutoff decreases, as was assumed, while the left hand side is positive because the cutoff in the low-risk market increase as was shown earlier. Hence, the cutoff in the high-risk market must increase as well.

□

D.VII Proof of Lemma 4

Proof. I am interested in the change in default probabilities from the Basel II to Basel III equilibrium for each bank, i.e. the change in the root of $\Pi_i(c_i, q_i^{*B2}, r(Q^{*B2}), z)$ and $\Pi_i(c_i, q_i^{*B3}, r(Q^{*B3}), z)$. Since costs c_i stay constant for each bank, I separate the effect of the change in interest rates ($r(Q)$ on $z_{i,crit}$) and the effect of the changing strategy (q_i on $z_{i,crit}$). I divide the latter into a portfolio reallocation effect due to changing share of high-risk to low-risk loans in the bank portfolio (γ_i on $z_{i,crit}$) and a leverage effect due to bigger or smaller size relative to equity (β_i on $z_{i,crit}$).

Before considering these three channels, I show that $\Pi_i(c_i, q_i, r(Q), z)$ has a unique root for mixed strategies as well. Note that in case of mixed strategies, Eq. (5.10) cannot be solved for $z_{i,crit}$. But

$$\frac{\partial \Pi_i}{\partial z} = -r_h(Q_h)q_h^v\frac{\partial PD_h}{\partial z} - r_l(Q_l)q_l^v\frac{\partial PD_l}{\partial z} < 0 \tag{5.89}$$

with

$$\frac{\partial PD_\eta}{\partial z} = \sqrt{\frac{\rho}{1-\rho}}\phi\left(\frac{\zeta_\eta + \sqrt{\rho}z}{\sqrt{1-\rho}}\right) > 0 \tag{5.90}$$

so that $\Pi_i(c_i, q_i, r(Q), z)$ is a decreasing function. Further it is monotone due to the monotonicity of the CDF in $PD_\eta(z)$. We know from optimality conditions of an equilibrium solution that $\Pi_i(c_i, q_i, r(Q), 0) \geq 0$ (note that $1 - PD_\eta(0) = p_\eta$). Therefore, $\Pi_i(c_i, q_i, r(Q), z) - r_d d_i$ has a unique root at $z_{i,crit} \geq 0$.

Now, I derive how each of the three channels affects the critical value of realization of systematic risk. First, consider unaffected constrained high-risk market incumbents that do not change their optimal portfolio strategy when the leverage ratio is introduced. For these banks only the market interest rate on high-risk loans changes. Since they are specialized on high-risk loans, we can solve Eq. (5.10) for $z_{i,crit}^\eta$ and get Eq. (5.57). Taking the derivative with respect to $r_h(Q_h)$ gives

$$\frac{\partial z_{i,crit}^h}{\partial r_h(Q_h)} = \frac{-\left(-MC_i + r_d \frac{e}{q_h^h}\right)}{r_h(Q_h)^2} \frac{\sqrt{\frac{1-\rho}{\rho}}}{\phi\left(\Phi^{-1}\left(1 - \frac{1}{r_h(Q_h)}\left(MC_i - r_d \frac{e}{q_h^h}\right)\right)\right)} > 0 \tag{5.91}$$

Given Corollary 1 , we know interest rate on high-risk loans increases. Hence, $z_{i,crit}^h$ increases and default probabilities of unaffected constrained high-risk market incumbents decrease.

Second, consider affected low-risk and high-risk market incumbents. In order to separate the effects caused through risk-shifting in the portfolio choice and delevering, we rewrite Eq. (5.10) by expanding with $\frac{d_i+e}{d_i+e}$, defining the share of high-risk loans in bank i's portfolio as $\gamma_i = \frac{q_{h,i}}{d_i+e}$, and defining bank i's leverage ratio as $\beta_i = \frac{e}{d_i+e}$ as

$$\begin{aligned} \Pi_i(c_i, \gamma_i, d_i, r(Q), z) = (p_h r_h(Q_h)\gamma_i + p_l r_l(Q_l)(1-\gamma_i) - MC_i)(d_i + e) \\ + \beta_i r_d (d_i + e) \ . \end{aligned} \tag{5.92}$$

The effect of delevering is

$$\frac{\partial \Pi_i}{\partial \beta_i} = (d_i + e) r_d > 0 \tag{5.93}$$

Affected low-risk market incumbents reduce their total size (changing from strategy l to v), which reduced their default probability according to Eq. (5.93), while affected high-risk market incumbents (changing from strategy h to v) increase their size, which increases their default probabilities.

The effect of a higher share of high-risk loans is

$$\frac{\partial \Pi_i}{\partial \gamma_i} = (q_h^v + q_l^v)\left(r_h(Q_h)(1 - PD_h(z)) - r_l(Q_l)(1 - PD_l(z))\right) \tag{5.94}$$

which could be either negative or positive depending on z in the following way:

$$\begin{aligned} &lim_{z\to-\infty} \quad r_h(Q_h)(1 - PD_h(z)) - r_l(Q_l)(1 - PD_l(z)) = r_h(Q_h) - r_l(Q_l) \\ &lim_{z\to\infty} \quad r_h(Q_h)(1 - PD_h(z)) - r_l(Q_l)(1 - PD_l(z)) = 0 \\ &\qquad\qquad r_h(Q_h)(1 - PD_h(0)) - r_l(Q_l)(1 - PD_l(0)) = p_h r_h(Q_h) - p_l r_l(Q_l) \end{aligned} \tag{5.95}$$

This means that the effect is positive for non-positive z and vanishes for very high z. But the effect can be negative, because $\frac{\partial \Pi_i}{\partial \gamma_i}$ has a local minimum given at $\hat{z}$ defined by

$$\frac{\partial^2 \Pi_i}{\partial \gamma_i \partial z} = 0 \quad \Leftrightarrow \quad \hat{z} = \frac{-\zeta_h^2 + \zeta_l^2 + 2\ln(\frac{r_h}{r_l})(1-\rho)}{2\sqrt{\rho}(\zeta_h - \zeta_l)} \ . \tag{5.96}$$

Therefore, as $z \to \infty$, $\frac{\partial \Pi_i}{\partial \gamma_i}$ must approach the limit 0 from below implying

$$\exists\ \tilde{z}\ : 0 < \tilde{z} < \hat{z} \quad s.t. \quad \begin{cases} \frac{\partial \Pi_i}{\partial \gamma_i} \geq 0 & \text{if} \quad z \leq \tilde{z} \\ \frac{\partial \Pi_i}{\partial \gamma_i} < 0 & \text{if} \quad z > \tilde{z} \end{cases} \tag{5.97}$$

Affected low-risk market incumbents increase their share of high-risk loans (changing from strategy l to v), which increases (decreases) their default probability according to Eq. (5.97) if the realization of systematic risk is below (above) $\tilde{z}$, while affected high-risk market incumbents (changing from strategy h to v) reduce their share of high-risk loans, which decreases (increases) their default probabilities if the realization of systematic risk is below (above) $\tilde{z}$.

Overall, if $z \leq \tilde{z}$, increasing interest rates and delevering reduce affected low-risk market incumbents' default probabilities and the reallocation of portfolio shares towards the riskier asset increases them. For affected high-risk market incumbents the reverse holds: Higher leverage and a higher engagement in the low yielding asset increase their default probabilities while the reallocation towards less risky loans decreases their default probabilities.

□

Chapter 6

Concluding remarks

Since the financial crisis major shortcomings of the market institutions were revealed and the role of the state in banking regulation and supervision gained momentum. A multitude of new regulations was introduced and states bailed out banks or gave guarantees for their safety. While some states now gradually retreat from their equity stakes in the bailed out banks, the new regulatory framework is set to last. It remedies past mistakes but cannot foresee the future. Safeguarding financial stability is an unrewarding task. In times of stability it is hard to pin down the contribution of the regulatory framework because of the missing counterfactual, but in times of crisis regulatory responses have to await their cause. Therefore, it is important to understand how market mechanisms work and how they can be instrumented to contribute to financial stability.

In Chapter 2 we studied how competition affects risk-taking. Using mortgage loan application data for the U.S. in the years 1995 to 2005, we find that banks with higher market power extended loans more cautiously. We highlight the role of information in the risk-taking channel. Banks that are better informed about the local mortgage market, might find it easier to control their risk-taking in order to protect their charter value. Our results show that, especially in banking, restricting competition might be a way to allow banks to extract rents from costly investments in information which are needed to assess risks correctly. The abundant possibilities to sell credit risk in the secondary market via securitization which emerged in the subprime mortgage market set few incentives for banks to put much effort into screening borrowers upfront or monitoring them thereafter. Insofar, it eroded rents from information acquisition and risk management. Important insights can be drawn for the current low interest rate environment which represses rents on classic intermediation. It should be considered whether banks with few market power might be inclined to neglect sound risk management in the search for yield.

In Chapter 3 we tested the hypothesis that pervasive government-ownership of banks restrict efficient market exit mechanisms. We find that mergers which were forced on the government-owned banks were beneficial to the banks as well as to firms connected to these banks. We derive the conclusion that the governmental banking sector holds back on a more efficient organizational structure, possibly due to political motives. Without passing any judgment on the political motives which initiated the design of government-owned banking systems, it nevertheless emphasizes the importance of a functioning market for corporate control as a complement to restricted competition in the product market in bringing about efficient outcomes.

The results in Chapters 4 and 5 both unveil possible side effects of banking regulation on economic efficiency and financial stability. In particular, the theoretical model in Chapter 4 asked how banks have to change their portfolio choice when a leverage ratio is introduced in addition to a risk-sensitive ratio which uses a value-at-risk approach. The main finding is that banks that are well diversified have to reshuffle their portfolio and specialize more on that asset where they have a relative advantage. It shows that well diversified banks might also have higher leverage. For instance, in the presence of economies of scale, it is reasonable to assume that diversification can only be achieved in connection with a certain scale of each business. We conclude that the leverage ratio can have negative consequences if it is seen as a tax on diversification in the form of assimilation of business models which creates systemic risks.

In Chapter 5 I investigate the effect of the interaction of a leverage ratio with additive risk-sensitive capital requirements on the allocation of market shares, average productivity of banks in the market, and financial stability. I find that average productivity in the banking market falls because rising interest rates attract new entrants with low productivity. Nevertheless, market shares in the high-risk credit market are reallocated mostly toward banks with higher productivity which can be seen as an improvement in economic efficiency as well as financial stability compared to the previous allocation. In general, the model points out that banks are differently affected and react differently depending on their productivity. In particular, it showed that a leverage ratio especially affects banks with high productivity.

Both theoretical results illustrate that the efficacy of regulation can be impaired if heterogeneity of banks with respect to productivity or their business model is not taken into account. While the papers in this thesis illustrate different instances where state interventions can have unintended consequences undermining economic efficiency, future research could contribute in turning these insights into a positive theory of how heterogeneity can be exploited by regulation to align the objectives of financial stability and economic efficiency.

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