Intervention in systemic banking crises

Homar, T.

Systemic banking crises often continue into recessions with large output losses. Governments and central banks intervene to preserve the key functions of the financial system and to mitigate the adverse impact of financial distress on economic growth. This thesis investigates how effective intervention measures are. Do they reduce the duration of recessions? And more specifically, what are the effects of bank recapitalizations? In addition, it analyzes the determinants of forbearance, a practice of extending or renewing loans to borrowers in distress, typical for banking crises. Finally, it evaluates the robustness of stress tests and other measures of bank vulnerability.

Timotej Homar (1986) obtained a BSc in Economics and an MSc in Business Administration at the University of Ljubljana, Slovenia. After completing an MPhil in Finance at the Tinbergen Institute in 2012, he continued as a PhD student at the University of Amsterdam. In 2015 he joined the European Central Bank to work in Banking Supervision.

Intervention in Systemic Banking Crises
Timotej Homar

Timotej Homar

Intervention in Systemic Banking Crises

641

Universiteit van Amsterdam

INTERVENTION IN SYSTEMIC BANKING CRISES

ISBN 978 90 5170 754 0
Cover design: Crasborn Graphic Designers bno, Valkenburg a.d. Geul

This book is no. **641** of the Tinbergen Institute Research Series, established through cooperation between Rozenberg Publishers and the Tinbergen Institute. A list of books which already appeared in the series can be found in the back.

Intervention in Systemic Banking Crises

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. D.C. van den Boom
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op woensdag 10 februari 2016, te 12:00 uur

door

Timotej Homar
geboren te Ljubljana, Slovenië

Promotiecommissie

Promotores:	Prof. dr. A.W.A. Boot, Universiteit van Amsterdam
	Prof. dr. S.J.G. van Wijnbergen, Universiteit van Amsterdam
Overige leden:	Dr. S.R. Arping, Universiteit van Amsterdam
	Prof. dr. T. Beck, Cass Business School
	Prof. dr. R.M.W.J. Beetsma, Universiteit van Amsterdam
	Prof. dr. H.P. Huizinga, Tilburg University
	Dr. T. Jochem, Universiteit van Amsterdam

Faculteit Economie en Bedrijfskunde

Acknowledgements

During the PhD I could talk with many people. I am grateful for the discussions we had, advice I got and support in various forms, which all contributed to this thesis.

First of all, I would like to thank my supervisors, Arnoud Boot and Sweder van Wijnbergen for their guidance on how to develop research ideas, structure problems and present results clearly. I greatly benefited from their extensive experience and insight into the key issues in banking. I acknowledge the support of the Gieskes Strijbis foundation, which funded the research project on which I worked at the University of Amsterdam.

In the final year of the PhD, I spent seven months at the European Central Bank. I am grateful to my coauthors Carmelo Salleo and Heinrich Kick, with whom I worked on projects of great relevance for both policy and research. I would also like to thank Paul Bochmann, with whom I enjoyed working together a lot. In summer 2013, I spent a month at the International Monetary Fund. I am grateful to Stijn Claessens, Luc Laeven, Fabian Valencia and Lev Ratnovski for making the visit possible and for their advice about research.

During the years at the University of Amsterdam, I got valuable teaching experience. I am grateful to Jeroen Ligterink, Florencio Lopez de Silanes and Zacharias Sautner that I could work with them and discuss my research with them.

Before I started the PhD, Matej Marinč explained me what research is like and about the Amsterdam Center for Law and Economics (ACLE) for which I am very thankful. Later, we met several times when I was in Ljubljana, and we worked together very successfully on organizing a conference.

At the University of Amsterdam I was part of the ACLE and the Finance Group of the Amsterdam Business School. At the ACLE, I could talk with people with very diverse research interests, ranging from law to political economy, industrial organization, experimental economics and banking. Being on the same floor with Barbara Abatino, Giuseppe Dari-Mattiacci, Wim Driehuis, Carmine Guerriero, Margherita Saraceno, Maarten Pieter Schienkel, Avraham Tabbach and Jeroen van de Ven broadened my perspective on research. I also enjoyed being involved in the Finance Group. In particular I am thankful to Stephan Arping, Erasmo

Giambona, Torsten Jochem, Jens Martin, Enrico Perotti, Florian Peters, Tomislav Ladika, and Radomir Todorov for the discussions about research we had.

I would like to thank Sidonie Rademaker, Lorena Zevedei, Mariëlle Lameijer, Charlotte Neuteboom, Manon de Vries, Hellen Borgmann, Chandra Doest, José Kiss, Wilma de Kruijf and Robert Helmink for their help with administrative and other issues. For the support during the job market I would like to thank Jose Luis Moraga-Gonzalez, Arianne de Jong and Christina Månsson.

The PhD would have been much less exciting without the time spent with friends and colleagues. With Lucy and Mikołaj, I had fun climbing as well as talking about very diverse topics. With Mark, we shared a supervisor and were also flatmates for more than two years. With Daniël I had many interesting discussion in Dutch during the time I was at the ECB. Eva, Josephine, Martijn, Ieva, Guilherme, Lukáš, Egle, Lin, Stephanie, Christiaan, Oana, Swapnil, Robin, Rob, Dorinth, Fleur, Richard, Natalya, Patrick, Alex, Samir and Steve were great colleagues at the University of Amsterdam. I will have great memories on the time in the Netherlands also because of the friends: Janko, Grega, Matija, Aleksandra, Anton, Helena, Tadej, Katja, Vincent, Luka, Naja, Sara, Aljaž, Maja and Kaja.

Finally, I am very grateful to my parents, Mihaela and Anton, my brother Ambrož and sisters Monika and Mirjam for their support and interest in my research.

Contents

Chapter 1
Introduction

1.1 Motivation and key questions

Systemic banking crises and the periods following them are characterized by substantial output losses, persistent declines in employment and large increases in public debt (Reinhart and Rogoff 2009). Intervention measures aimed at preserving financial stability in the midst of crises often require sizeable government funding (Honohan and Klingebiel 2003). Although the costs of intervention are large, they typically account only for a minor part of the increase in public debt. The main reason for the increase in public debt are the lost tax revenues from lower growth. This suggests that taking policy measures to limit the impact of financial distress on the real sector and thereby reduce output loss may well be worth the costs. How effective are policy measures in this respect? How precisely they work? What can be done to prevent crises before they even occur? These are some of the questions addressed in this thesis.

Output costs of banking crises are so large because of multiple mechanisms through which shocks to the banking sector are transmitted to the real sector. The main channel seems to be reduced loan supply by weak banks. An example of evidence for this is provided by Ivashina and Scharfstein (2010), who show that lending to new firms fell sharply during the recent banking crisis. Moreover, Chodorow-Reich (2014) observes that borrowers with a pre-crisis relationship to banks that were hit harder after the collapse of Lehman were less likely to obtain loans and paid higher interest rates if they got them. Importantly, he finds that this has real consequences, among others in lower employment. As shown by Jimenez, Ongena, Peydro and Saurina (2012) on Spanish loan level data, banks in general respond to adverse economic conditions with a reduction in loan supply but the effect is particularly strong for banks with low capital. Borrowers of affected banks are not able to offset the effects by borrowing from other banks. Further evidence that weak banks hamper economic activity is provided by Kroszner, Laeven and Klingebiel (2007) and Dell'Ariccia, Detragiache and Rajan (2008), who

find that bank dependent firms grow slower during banking crises than those less dependent on external financing.

In addition to the reduced loan supply, another channel through which a weak banking system leads to output losses is forbearance, a practice by banks to offer distressed borrowers better terms or roll over the problematic loans. If a borrower's difficulties are liquidity related, forbearance can be the optimal response. However, if they are solvency related, weak banks may use forbearance only to delay recognition of losses and gamble for resurrection (Niinimaki 2007; Bruche and Llobet 2014). In the extreme case when banks evergreen, i.e. continue to renew, loans to insolvent borrowers and at the same time reduce lending to new borrowers with good projects, such behavior results in a long stagnation like the Japanese lost decade (Peek and Rosengren 2005; Caballero, Hoshi, and Kashyap 2008).

The impact of banking crises is broad also because the initial shocks to the banking sector are amplified by contagion mechanisms such as depressed collateral prices due to fire sales (Diamond and Rajan 2011) and hoarding of liquidity (Cornett et al. 2011). Furthermore, the sovereign-bank loop where weak banks hold substantial amounts of debt issued by overindebted governments can be a major source of instability (Lane 2012; Acharya, Drechsler, and Schnabl 2014). Firms more exposed to banks affected by the Eurozone sovereign debt crisis suffered consequences in the form of lower sales, reduced capital expenditures and depressed employment growth (Acharya et al. 2014).

All these costs of banking crises call for regulatory intervention. Choosing the right type of policy measures is no easy task. Information available to regulators is far from what would be desirable. Moreover, the ability to implement policies may be compromised by the sustainability of sovereign debt. When public debt is high, raising additional funding needed for intervention may not be possible at all or can amplify the problems in banks that hold substantial amounts of sovereign debt, making the intervention less effective (Van der Kwaak and Van Wijnbergen 2014). One of the objectives of intervention is also to provide support in a way that does not create too large moral hazard due to bailout expectations in future. Finally, the incentives of regulators may not be to maximize welfare but also to pursue other objectives such as preserving their reputation (Boot and Thakor 1993). Because each of these different objectives may favor a different type of intervention, it is not clear what the optimal policy response should be.

Theoretical models provide explanations of possible mechanisms of how intervention measures work, what problems they solve and the side effects they may have. Empirical research on the other hand sheds light on what intervention measures actually achieve, how large their

effects are and whether they are consistent with theoretical predictions. This can provide some guidance on what should be considered when deciding about intervention but does not give definite answers on optimal policy. The existing literature has shown that measures like bank recapitalizations, guarantees on bank liabilities and liquidity support, which are often used during banking crises, at least to some extent achieve their direct objectives. One of the key questions that has not yet been clearly answered is: *how do intervention measures during banking crises affect macroeconomic outcomes?* And more specifically: *do intervention measures reduce the duration of recessions related to banking crises*? Looking at the effects of intervention measures at bank level, one may ask what their direct effects are. For example: *do banks increase lending after they are recapitalized? Are banks that are recapitalized able to attract more deposits and raise additional funding on the market? Does a recapitalization induce banks to clean up their balance sheets by making adequate provisions for loan losses?*

One of the main problems characteristic for banking crises is forbearance. Detecting forbearance early could be very beneficial. It would improve regulators' ability to react when problems are not widespread yet and avoid the need for extensive intervention in a later stage. For this purpose it is worth asking: *what factors predict the extent of forbearance across banks? Are weak banks more likely to forbear on bad borrowers? What role does the quality of banking supervision play?*

To maintain financial stability without the need for government intervention each time when banks are hit by an adverse shock, banks need to hold sufficient capital that they can withstand such shocks. In order to assess their resilience, stress tests and other measures of bank vulnerability are used. Both stress tests and the other measures critically depend on their modelling assumptions and stress scenarios, which raises the following questions: *how much can we rely on the results of stress tests and those of market based measures? How do losses in different stress scenarios relate to various factors expected to predict bank vulnerability?*

1.2 Methodology and important concepts

In this thesis I address the questions listed above. The approach used, is analysis of cross-sectional and panel data, at country or at bank level, depending on the questions analyzed. The main challenge in estimating the effects of policies is that policies are endogenous – they are not random but are decided by governments and central banks, whose decisions are likely to depend on the severity of the problems at stake and expectations about future conditions. Identifying the effects is only possible if a random component in intervention can be isolated. I develop empirical setups that make it possible to overcome the main endogeneity problems and estimate the effects of intervention at both macro and micro level, explain variation in the extent of forbearance across banks and evaluate the robustness of stress test outcomes.

One of the themes present in all chapters of the thesis is the problem of undercapitalized banks, which is conceptually very similar to the debt overhang problem known from corporate finance (Myers 1977). A firm with large existing debt will only invest into a positive NPV project if the payoff of the project is sufficient that the existing debt can be repaid and some value remains for the shareholders. If existing debt is very large an overindebted firm will not invest into positive NPV projects because all value created accrues to the firm's creditors. New investors are unwilling to lend to such a firm or invest in its shares unless the new project can be separated from the existing debt or the outstanding debt is reduced through a renegotiation. The existing shareholders can increase their expected payoff by increasing the risk of the firms' activities enough that in some states all existing debt can be repaid and there is some residual value that accrues to them. Such risky projects may have negative NPV, yet the shareholders choose to implement them. Thus a firm subject to debt overhang will pass incremental projects with positive NPV and invest into very risky projects despite their negative NPV. In case of an undercapitalized bank this means that it may reduce lending to creditworthy borrowers because the return from lending to them is too small, and at the same time keep funding very risky borrowers where high but unlikely returns are possible.

1.3 Thesis outline

Chapter 2 provides a review of literature, primarily empirical, on the effects of intervention measures during banking crises, micro- and macroprudential policies, and risks for financial stability that recently gained relevance. It describes a broader context in which the contributions of the next chapters can be understood.

Chapter 3 analyzes recessions related to systemic banking crises, asking what difference it makes if governments intervene decisively during systemic banking crises to recapitalize distressed banks versus the approach of regulatory forbearance. Under regulatory forbearance distressed banks are likely to become undercapitalized zombie banks, kept alive only by government guarantees and liquidity support by the central bank. Undercapitalized banks have incentives to roll over loans to borrowers in distress, gambling on the small probability that the troubled loans would fully repay although it would be optimal to restructure or liquidate the bad loans in order to maximize their expected payoff. Recapitalizing such banks sufficiently, solves the incentive problem, which leads to a better allocation of lending and ultimately to a higher output. After describing this mechanism in a simple theoretical model, I analyze recessions related to 68 systemic banking crises since 1980 (28 of these correspond to different countries during the recent global financial crisis). I use a duration model with fixed effects to address the

critical endogeneity concern – the correlation between intervention and crisis severity. The results show that bank recapitalizations substantially reduce recession duration, by roughly 40%. A typical recession from the recent global financial crisis is expected to last 6 quarters if banks are recapitalized in the second recession quarter but would go on for 11 quarters without bank recapitalization.

In Chapter 4, I analyze the effects of bank recapitalizations at the micro level – how they affect bank lending, funding and management of nonperforming loans. The approach controls for how distressed a bank is just before being recapitalized. I find that banks that receive a sufficiently large recapitalization increase lending, raise additional funding and clean up their balance sheets. In contrast, banks that receive a small recapitalization relative to their capital shortfall reduce lending, shrink assets and suffer a drop in deposits and interbank borrowing. These results suggest recapitalizations need to be large enough to lead to new lending.

Chapter 5 investigates, what factors can predict the extent of forbearance across banks. Forbearance is a practice of granting concessions to troubled borrowers, typically in the form of a prolongation of maturity or refinancing of the loan. While economically justified in some circumstances, it can be used by banks in order to reduce the need for provisions and conceal potential losses. Without looking at the detailed information about each loan, it is difficult to measure forbearance. I exploit the outcomes of the asset quality review conducted by the ECB in 2014 on 130 Eurozone banks to obtain measures of forbearance. The results highlight weak macroeconomic conditions, lax bank supervision and measures of bank weakness, both balance sheet and market based, as the key factors explaining variation in forbearance.

Chapter 6 evaluates the robustness of the ECB/EBA 2014 stress test and SRISK by explaining the stress impact, i.e. losses in the stress scenario, with variables expected to predict bank vulnerability. I find that the outcomes of the ECB/EBA stress test can be explained by adverse macroeconomic conditions, bank balance sheet characteristics, CDS spreads and abnormal returns on bank stocks, whereas the SRISK stress impact is primarily determined by bank leverage ratio. The results suggest that SRISK underestimates the stress scenario losses of banks that have little capital to start with and overestimates the impact on well capitalized banks. This is likely due to the design of SRISK, which is derived from bank stock returns and may not properly account for losses that wipe out entire bank equity. The findings provide some reassurance about the results of stress tests based on a detailed review of bank exposures and point at possible limitations of market based measures. Capital shortfall computed using SRISK is the key control variable in the analysis in Chapter 3. The possible bias of SRISK in favor of undercapitalized banks could raise doubts about the results obtained in Chapter 3. The

robustness checks, however, show that the findings about the effects of bank recapitalizations do not depend on using the shortfall measure based on SRISK.

Chapter 7 summarizes the main findings of the thesis and concludes.

Chapter 2
Policies for Maintaining Financial Stability: A Literature Review

2.1 Introduction

This chapter reviews literature, mostly empirical, on the effects of intervention measures used during banking crises as well as micro- and macroprudential policies and discusses some of the new challenges for financial stability. The contributions of the following chapters fit into the broader context of policies related to financial stability described here.

2.2 Intervention measures during banking crises

The main measures directed toward distressed banks during banking crises are bank recapitalizations, liquidity support and guarantees on bank liabilities. The effects of bank recapitalizations on lending are among others analyzed by Black and Hazelwood (2013) an Li (2013), who look at US banks that received injections of preferred stock with warrants under the TARP program during the recent crisis. They find a positive effect on loan supply, while Duchin and Sosyura (2014) observe increased risk taking by banks that received TARP funds. Berger and Roman (2015) provide evidence that TARP support contributed to job creation and less bankruptcies, suggesting that the effects of recapitalizations on the economy at large are positive. The existing literature has not yet been able to prove the effect of bank recapitalizations on macroeconomic outcomes. The effect of intervention on aggregate output is hard to isolate from all other factors that affect economic growth. In Chapter 3, I use an approach that makes this possible. By controlling for the severity of banking crises, in a duration model, I find that recapitalizing banks substantially shortens recessions related to systemic banking crises. Giannetti and Simonov (2013) observe that recapitalized banks increase lending to creditworthy

borrowers only if the injected amount was sufficient. If a bank is still undercapitalized after an injection, the additional funds are instead channeled to distressed, often insolvent, borrowers. Similarly as they, I find in Chapter 4 that small recapitalizations do not have the same effect as large ones. I analyze recapitalizations of European banks during the recent crisis. Recapitalizations only lead to an increase in lending if they are large enough. In contrast, if a bank receives a small recapitalization relative to its capital shortfall, it shrinks its assets, presumably to improve the capital ratio. Compared to the existing literature, which focuses only on lending, I find that after being recapitalized banks also attract more deposits, are able to borrow more on the interbank market and clean up their balance sheets.

Liquidity support provided by central banks is another measure commonly used in banking crises. Its main purpose is to preserve the stability of the financial system by helping solvent banks overcome liquidity problems. In some crises it is applied very extensively, also to support banks with solvency problems, which may create zombie banks with incentives to evergreen loans to distressed borrowers. Andrade et al. (2015) investigate the effects of liquidity support provided by the ECB in the form of long-term refinancing operations (LTRO) in 2011 and 2012 and find positive effects. More precisely, they observe that banks that took up larger LTRO amounts increased lending to nonfinancial firms, in particular to the large ones. Most of the additional lending was granted to firms that did not have a longstanding relationship with the banks, implying it was not used for evergreening of bad loans. Moreover, the results suggest that the long (3-year) maturity of the LTRO was crucial for its positive effect on bank lending.

To prevent bank runs, governments in some banking crises guarantee a substantial proportion of bank liabilities, not only the insured deposits. Laeven and Valencia (2012a) find that such guarantees help limit the pressure on banks, which can be seen in the reduced need for liquidity support. They discourage runs on banks by domestic creditors but do not do much to reduce withdrawals of foreign liabilities. Interestingly, they find that guarantees are more effective if accompanied by bank restructuring measures that restore trust in the solvency of the banking system.

While the empirical evidence shows that intervention measures used in systemic banking crises achieve their objectives – at least to some extent – there are many concerns about the moral hazard implications, distortion of competition and other undesirable consequences of intervention measures. Knowing that when many banks are distressed at the same time, the regulator is more likely to bail them out, banks have incentives to increase their maturity mismatch (Farhi and Tirole 2012) and invest similarly, which results in a higher correlation across their assets (Acharya and Yorulmazer 2007). Brown and Dinc (2009) provide evidence

for this too-many-to fail effect. They find that banks are less likely to be closed or taken over by governments if other banks are weak at the same time. They obtain these results on a sample of banks from emerging countries. Damar, Gropp, and Mordel (2012) find that banks with a larger probability of receiving government support, reflected in the difference between credit ratings with and without the expected support, tend to increase risk in normal times and reduce it in crisis times. The increased charter value may give banks incentives to limit risk in a crisis but the expectation of support leads to more risk taking ex ante, in normal times. A more direct evidence for the increased risk taking because of guarantees is found by Gropp, Gruendl, and Guettler (2013). Removing guarantees on German savings banks resulted in a reduction of risk. Guarantees, explicit as well as implicit, also create competitive distortions. Larger implied bail-out probabilities of some banks lead to a substantial increase in risk by their competitors without expected state support because of the competitive pressure of banks enjoying an implicit subsidy by the state (Gropp, Hakenes, and Schnabel 2011). Similarly, Berger and Roman (2013) document that banks that received TARP funds gained market share and market power.

2.3 Microprudential policies

Being aware of all the undesirable incentive effects of intervention measures as well as their fiscal costs, regulators may want to limit their use as much as possible in order to incentivize banks to manage risk properly and thereby reduce the probability of crises occurring in the first place. However, the ability to commit to no bailouts in severe crises is questionable and there are always some neglected risks (Gennaioli, Shleifer, and Vishny 2015), which if they materialize, require decisive intervention despite the moral hazard and other concerns. To lower the probability of future crises, micro- and macroprudential policies are used. Microprudential policies focus on insuring that banks are sufficiently capitalized and that they have adequate risk management in place. What the right level of capital should be, is fiercely disputed by regulators, academics and representatives of the banking industry. Among the academics, with some exceptions, the consensus is that banks should hold more common equity as a proportion of their total assets than they currently do. The arguments for more capital are comprehensively summarized by Admati et al. (2013). On the other hand the main objection against increasing capital requirements is that this would lead to reduced lending and lower output. Regulators are also concerned about the transition period in which banks have to raise new equity or might shrink their assets to avoid the dilution of existing shareholders.

Another critical aspect of microprudential regulation is reliable reporting of bank asset values. During systemic banking crises the incentives for banks to overstate asset values and

make too little provisions for losses are high. Laeven and Majnoni (2003) document underprovisioning by banks in a large cross-section of countries. Huizinga and Laeven (2012) show that US banks significantly overstated the values of real estate-related assets during the recent financial crisis. A typical way for banks to avoid provisioning for loan losses is to forbear the problematic loans. Since forborne loans do not have to be immediately classified as impaired, the required provisions on loans that are forborne are lower. In Chapter 4, I find that the extent of forbearance across banks can be predicted by adverse macroeconomic conditions, lower quality of bank supervision and measures of bank weakness, both balance sheet and market based. Maintaining good reporting standards is all the more important knowing that during banking crises regulators have incentives to become laxer on banks. The regulator may find it optimal to forbear on weak banks to avoid reputational damage and prevent contagion due to creditors making inferences about the stability of other banks subject to the same regulator (Morrison and White 2013). If the perceived ability of the regulator is high initially, the regulator does not have to resort to forbearance to preserve reputation. Whereas if it is intermediate, forbearing may even be socially optimal. Higher standards of reporting in normal times contribute to better monitoring as well as the credibility of the regulator, which reduces the need for forbearance in crisis times.

2.4 Macroprudential policies

Macroprudential policies aim to protect the stability of the financial system as a whole. Microprudential approach alone is insufficient when multiple financial institutions are hit at the same time (Hanson, Kashyap, and Stein 2011). A single bank that suffers a shock can restore its capital ratio in two ways – both acceptable under the microprudential view – either by raising additional equity or by shrinking the asset base. If many banks attempt to sell-off assets at the same time, the fire sales can severely exacerbate the stress. Macroprudential measures are needed to address such problems. The main ones focus on mitigating the procyclicality of capital requirements, reducing bank incentives for activities contributing to systemic risk, insuring banks maintain sufficient liquidity buffers and a stable funding structure, and imposing limits on loan to value (LTV) and debt to income (DTI) ratios to prevent bubbles in real estate lending (Galati and Moessner 2012). Macroprudential instruments can have multiple effects at the same time, some beneficial and some potentially harmful. Jiménez et al. (2014) shed some light on this by analyzing dynamic provisioning in Spain. In the good times banks subject to a higher dynamic provisioning requirement reduced loan supply without the affected borrowers suffering much because they were able to switch to other banks. However, banks that had to

provision most, increased risk taking by directing a greater extent of their lending into loans with high interest. During the crisis banks with larger accumulated provisions increased loan supply compared to banks with low buffers. Firms borrowing from banks with low accumulated provisions, which reduced loan supply during the crisis, were not able to switch to other banks. This ultimately resulted in a reduction of employment and a decrease in firm survival. To mitigate the reduction in lending, the Spanish regulator lowered the floor for minimum provisions. This led banks, particularly those close to the limit, to temporarily increase lending. But the increase disproportionally benefited borrowers with higher leverage and long existing relationship with the bank, which could point at zombie lending. Thus countercyclical capital buffers can help smooth lending cycles but can also result in additional risk.

Bank risk taking also introduces a potential conflict between the objectives of monetary and macroprudential policies. Dell'Ariccia, Laeven, and Marquez (2014) model the effects of a change in the risk free rate on bank monitoring. When banks can endogenously adjust leverage, they respond to a reduction in real interest rates by increasing leverage and asset risk. Evidence for such increases in risk taking is found by Dell'Ariccia, Laeven, and Suarez (2013) and Ioannidou, Ongena, and Peydro (2014).

2.5 Stress tests and measures of systemic risk

A crucial tool to assess the resilience of the banking sector are stress tests that estimate bank losses under an adverse macroeconomic scenario. In the recent years regulators started to perform them on a regular basis. Furthermore, academics have proposed various additional measures to detect buildup of systemic risk. CoVaR can be used to measure the contribution of individual financial institutions toward the risk of the entire financial system (Adrian and Brunnermeier 2014). SRISK, proposed by Acharya, Engle, and Richardson (2012), measures the expected capital shortfall of a bank in the event of a shock that results in a large drop of the general stock market index. The advantage of such measures is that they can be estimated on a continuous basis using market data. In Chapter 5, I show that such measures can also be prone to bias. By explaining the outcomes of the ECB/EBA 2014 stress test and the stress scenario losses implied by SRISK with factors expected to predict bank vulnerability, I show that SRISK considerably underestimates the losses of weakly capitalized banks.

2.6 More risks for financial stability

Further challenges concerning financial stability lie ahead. The recent events have highlighted the need for international coordination both in financial regulation and in intervention during

crisis periods. In a cross-country analysis Ongena, Popov, and Udell (2013) show that banks subject to lower barriers to entry and more restrictions on bank activities at home adopt laxer lending standards in their subsidiaries abroad. Beck, Todorov, and Wagner (2012) find evidence that the extent of a bank's cross-border activities influences regulators' decisions about how quickly to intervene when the bank is distressed. Banks with a larger share of foreign equity are intervened early when the level of their distress is still relatively low, while those with more foreign assets and deposits are intervened later. These issues point at the need for international cooperation. Zoican and Górnicka (2015) provide a model of a banking union showing that bailout decisions under a common resolution mechanism are efficient but bank incentives for monitoring may deteriorate as a result of the higher probability of receiving a bailout. This stresses the need for implementing adequate supervision in addition to the common resolution.

An increasingly greater concern for financial stability is the shadow banking sector, which is not subject to capital requirements and banking supervision (Gorton and Metrick 2010). Banks may use special purpose vehicles to engage in capital arbitrage (Górnicka 2014) and might voluntarily rescue them only to avoid signaling their own weakness (Segura 2014). The shadow banking sector is growing and becoming systemically important because of its size and links to the regulated banks.

Another potential concern is the new instruments that are being developed to improve the resilience of the financial system. Such innovations can help safeguard financial stability but could also present additional risk. Conditionally convertible (CoCo) bonds are an example. They are designed to provide banks with loss absorption capacity when it is needed, while being a cheaper source of capital than common equity. CoCo bonds are hybrid securities that convert into shares or their principal is written down when bank capital ratio falls below a trigger level. Martynova and Perotti (2015) provide a theoretical framework in which the effects of CoCo bonds on bank risk can be compared with common equity and subordinated debt. Calomiris and Herring (2013) suggest that CoCos designed to dilute shareholders at conversion could be used to incentivize banks to raise additional equity when they still can. Chan and Van Wijnbergen (2014), however, show that CoCo bonds could also be a source of contagion when banks hold correlated assets and investors update their beliefs about other banks upon observing a conversion of CoCos at a particular bank.

Maintaining financial stability is a major challenge. The existing research has shown that intervention in systemic banking crises is effective but also has significant undesirable side effects. Many interesting questions are open for future research.

Chapter 3
On Zombie Banks and Recessions after Systemic Banking Crises

3.1 Introduction

As early as 2009, Reinhart and Rogoff (2009) pointed out that "recessions surrounding financial crises are usually long compared to normal recessions". Their research highlights surprisingly large declines in output, slow recoveries and large and persistent negative effects on unemployment, public debt and fiscal deficits in the aftermath of banking crises. The subsequent experiences in the United States and particularly in Western Europe seem to lend further support to their findings. Interventions during financial crises are not only important to preserve the key functions of the financial system but also to mitigate the macroeconomic consequences of financial distress. What are the true costs of forbearance i.e. the costs that zombie banks impose on society? In particular, what impact does regulatory forbearance have on recession duration? And what can we say about alternative modes of intervention? In this chapter we begin to answer those questions by empirically investigating durations of recessions after 68 systemic banking crises from the period 1980 to 2013.

The existing literature has documented that intervention measures have high fiscal costs (Honohan and Klingebiel 2003). Whether the measures shorten recessions is less clear. Claessens et al. (2005) find that the fiscal costs of banking crises and output loss depend on the quality of institutions, but they do not discuss the nature of the interventions taken. Laeven and Valencia (2011) provide suggestive microeconomic evidence that the mode of intervention matters: they show that in times of banking crisis firms more dependent on external finance grow faster when bank recapitalizations are done. We investigate how effective intervention measures are from a macro perspective: how do they affect recession duration? The main instrument we focus on is bank recapitalization. We find that it substantially reduces recession duration. We also look at other intervention mechanisms such as liquidity support and

guarantees on bank liabilities but find little or no positive effect of these measures on the expected recession duration.

Using a duration model on a panel dataset, enables us to take into account that intervention is endogenous to crisis severity. Governments are more likely to intervene in severe than in mild crises. We think about crisis severity as of a measure of the scale of problems in the banking sector, which would determine recession duration if there was no intervention. As such, crisis severity is not observable. Using a particular policy in a banking crisis affects the probability of recovery and is at the same time informative about crisis severity. If a measure increases the probability of recovery but is more likely to be used in severe crises, it may appear that the measure is not effective unless the estimation controls for crisis severity. To control for crisis severity, we make some assumptions about its structure. We assume that the severity has two components: a time-invariant component that is correlated with intervention and a time-varying component that is not correlated with intervention. The time-invariant component can be interpreted as the shock to the banking sector that has caused a banking crisis. We let this shock be correlated with the average level of the intensity of intervention over the recession period. Our identification is based on the deviations of intervention from its average over the whole recession period.

The estimation results show that bank recapitalizations have a highly significant positive effect on the probability of recovery. We calculate the model-predicted recession duration separately for a typical crisis where bank recapitalizations were never done and a typical crisis where banks were recapitalized at some point. Crises with bank recapitalizations are on average much more severe than crises where recapitalizations were not used. The typical recession (from the sample of 2007 to 2013 crises) during which banks were recapitalized is predicted to last 6.3 quarters, but if banks would not have been recapitalized, the same recession would have gone on for 11 quarters. For less severe crises (where no recapitalizations took place), the recession is expected to last 5.6 quarters without bank recapitalizations but only 3.5 quarters if banks are recapitalized. These findings strongly document the distortions caused by zombie banks and the costs of forbearance to society.

To set the stage for the empirical analysis, we present a theoretical model that analyzes the effectiveness of bank recapitalization. The key inefficiency in the model is that after a shock to their assets, banks may have an incentive to shift risk by rolling over loans to borrowers in distress. Recapitalizing such zombie banks mitigates that incentive problem. Other interventions only prevent bank failures but do not address the incentive problem and therefore do not improve welfare as much as bank recapitalization. In a simple macroeconomic extension, we

show that recapitalizing banks leads to stronger recovery (higher expected future output) than one can expect in a zombie bank environment with distorted roll over incentives. Our empirical results are consistent with the predictions of the theoretical model.

The chapter is organized as follows. Section 3.2 discusses the related literature. Section 3.3 presents the theoretical model. The empirical methodology is explained in Section 3.4 while Section 3.5 describes the data. Results are presented in Section 3.6. Robustness checks are in Section 3.7. Section 3.8 concludes.

3.2 Review of related literature

This chapter builds on the empirical literature on financial crises, which documents large output losses and substantial fiscal costs of intervention (Reinhart and Rogoff 2009; Hoggarth, Reis, and Saporta 2002; Honohan and Klingebiel 2003). Several authors focus, like we do, on the interaction between public policy and output losses after a crisis. A critical concern is the endogeneity of policies to crisis severity. To address it Claessens, Klingebiel, and Laeven (2005) look at residual fiscal outlays above the amount predicted by proxies for quality of institutions. They find that higher residual fiscal costs are related to larger output losses. The endogeneity problem can sometimes be circumvented by switching to industry-level data. Kroszner et al. (2007) and Dell'Ariccia et al. (2008) investigate the impact of high dependence on external finance and find that such firms grow relatively slower in times of banking crises. Using the same approach, Laeven and Valencia (2011) find that bank recapitalizations have a positive effect on growth of financially dependent firms. We control for the endogeneity of policies by modeling the crisis severity as a crisis-specific fixed effect that can be correlated to the average level of intervention over the quarters of a crisis.

In this chapter, we compare bank recapitalization against regulatory forbearance – not intervening or using only measures that do not address the undercapitalization problem directly. Japanese experience points at severe consequences of forbearance. Poorly capitalized banks tend to "evergreen" loans to insolvent firms (Peek and Rosengren 2005; Watanabe 2010). Because the inefficient firms then do not exit their industries, more productive firms do not prosper, or may delay entry, which can lead to a long stagnation (Caballero, Hoshi, and Kashyap 2008). In contrast, Poland in the 1990s stands out as an example of a successful restructuring. Banks were recapitalized and incentivized to become agents of change in the restructuring of loss-making state owned enterprises. The ultimate privatization proceeds from the sale of banks and restructured firms, as well as bank capitalization ratios at the end of restructuring, far exceeded initial expectations (Van Wijnbergen 1997).

In addition to channeling credit to insolvent borrowers, weak banks impose another inefficiency by lending less to good borrowers. Chodorow-Reich (2014) documents this effect using a dataset on syndicated lending in the period before and after the Lehman collapse. Due to the stickiness of banking relationships, firms whose lead bank is weak are not able to increase borrowing from other banks enough to offset lower borrowing from the weak bank. Consequently, those firms pay higher interest rates and reduce employment more. The distortions of zombie banks can be mitigated by recapitalizations. Li (2013) finds that capital injections under the Troubled Asset Relief Program increased credit supply. Similarly, Calomiris et al. (2013) find that after the passage of Emergency Banking Relief Act in March 1933 (during the Great Depression) injections of preferred stock into distressed but not deeply insolvent banks increased their probability of survival and loan growth. Giannetti and Simonov (2013) show that recapitalizations need to be large enough to be effective. Japanese banks that were sufficiently recapitalized increased lending and reduced exposure to zombie firms, whereas the banks that were still in breach of capital requirement after receiving a capital injection, did not increase loan supply but only extended more loans to zombie firms.

3.3 Model

We propose a simple theoretical model describing bad loans as a possible channel through which intervention could affect recession duration. In contrast to the existing literature on intervention, which focuses on adverse selection problems (Diamond and Rajan 2011; Philippon and Schnabl 2013; Philippon and Skreta 2012; Tirole 2012) or on the ex ante moral hazard created by bailout expectations (Farhi and Tirole 2012), we analyze the ex post moral hazard in lending that arises after a shock to bank assets. Our model is perhaps most closely related to a very early contribution to the literature on bank intervention, Berglof and Roland (1995), who investigate why so called soft budget constraints emerge. They analyze bank incentives to refinance vs. liquidate loans to distressed borrowers. They find that banks that have sufficient capital enforce discipline on borrowers and thereby induce effort in firms, while those with little capital refinance inefficient firms in order to benefit from a government bailout. Our analysis is also related to Spargoli (2012) who analyzes bank decisions to liquidate bad loans from a different perspective. Despite the lower payoff, banks tend to roll over bad loans in order not to reveal themselves as bad types to be able to borrow at a lower rate. Hiding loses and regulatory forbearance ultimately result in funding being allocated to inefficient projects and lower welfare. Core to our model is that the presence of nonperforming loans can give banks ample opportunities for risk shifting. Nonperforming loans can be very high in systemic

banking crises. The average peak value of the ratio of NPLs to total banking assets during the 65 crises from the dataset of Laeven and Valencia (2012a) is 20%.[1] The model is set up to demonstrate how bank recapitalization improves incentives of a zombie bank and helps to motivate the subsequent empirical analysis.[2]

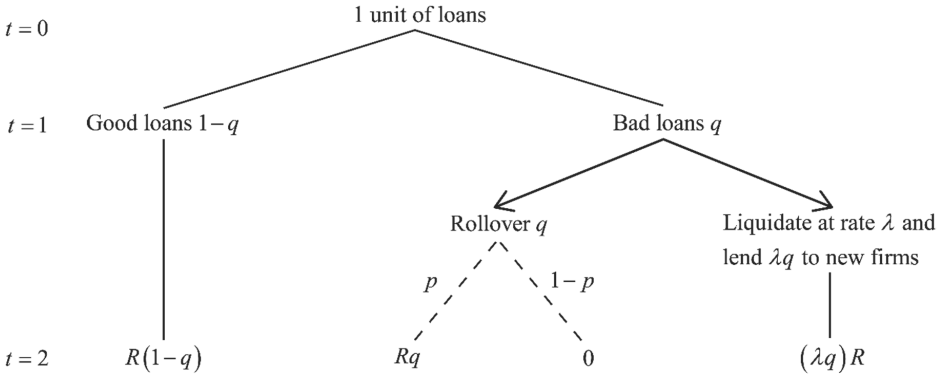


Figure 1: Loan characteristics

At $t = 0$ the bank makes 1 unit of loans. At $t = 1$ the bank and the regulator observe the quality of loans. A proportion of loans $1 - q$ is good; the remaining q are bad loans. At $t = 2$ good loans repay with certainty a cash flow R per unit of lending. If the bank rolls over the bad loans, they repay R with probability p and zero otherwise. If the bank liquidates bad loans it gets λ per unit of liquidated bad loans. The proceeds from liquidation are lent to new firms at a rate R.

3.3.1 Timeline of events

There are two time periods. The first one lasts from $t = 0$ until $t = 1$ and the second from $t = 1$ till $t = 2$. There are three types of agents: a bank, depositors and the regulator. The regulator is only active from $t = 1$ on if there is a banking crisis.

- At $t = 0$ the bank raises k of equity and $1 - k$ of debt with maturity of one period. It makes 1 unit of loans to firms that invest into two-period projects.

[1] The average value in crises before 2007 is 26%; in crises after 2007 it is 11%. The medians are 24% and 6.5%, respectively.

[2] Another channel for the effectiveness of intervention is related lending. La Porta, Lopez-de-Silanes, and Zamarripa (2003) examine related lending in the period following the Mexican crisis and find that related loans have more favorable borrowing terms, probability of repayment is lower and recovery rates are smaller than on loans to nonrelated parties. Their analysis also suggests that banks sharply increase the amount of related lending after being hit by a shock. The existence of related lending has been documented also in other countries(Laeven 2001; Johnson and Mitton 2003; Charumilind, Kali, and Wiwattanakantang 2006).

- At $t=1$ the bank and the regulator observe the quality of bank loans. A proportion of loans $1-q$ is good; the remaining q are bad loans. Depositors may withdraw. If the bank cannot obtain funding it liquidates the loans as much as necessary to repay depositors. The liquidation value of both good and bad loans is $\lambda<1$ per unit of a loan. If the bank can secure funding for the second period, it makes a decision about the bad loans. It either rolls them over as if they were good loans or liquidates them and lends the proceeds to new firms.
- At $t=2$ the bank collects loan repayments. Good loans repay a cash flow R with certainty. Bad loans that were liquidated and reinvested repay λR per unit of initial lending, with certainty. Bad loans that were not liquidated repay R with probability p and zero otherwise. Depositors are repaid. Bank shareholders get the residual.

3.3.2 Depositors

Depositors are risk neutral and in expectation require a gross return equal to the risk free rate, which is normalized to 1. At $t=0$ the bank raises $1-k$ of deposits, for which it promises to repay D at $t=2$ or $\sqrt{D}$ at $t=1$ if depositors withdraw early. If they withdraw at $t=1$, the bank tries to raise new debt in the amount of $\sqrt{D}$ to repay the existing depositors. In case it cannot repay the promised amount, the depositors get all cash flows the bank can collect. If the bank is insolvent at $t=1$ the depositors get λ since the bank has to liquidate its entire loan portfolio. If the bank is insolvent at $t=2$, which can occur when bad loans did not perform well, the depositors get $R(1-q)$.

3.3.3 Bank

The bank pursues the interests of its shareholders. It is assumed that an incentive structure is in place that insures that the interests of bank managers do not diverge from those of bank shareholders. At $t=0$ bank shareholders pay in k of equity, on which they require an expected return strictly larger than the risk free rate. Assuming a premium on bank equity is consistent with the existing literature (Hellmann, Murdock, and Stiglitz 2000; Repullo 2004; Dell'Ariccia and Marquez 2006; Allen, Carletti, and Marquez 2009). The higher required return gives bank shareholders an incentive to lever up as much as possible. Bank shareholders are residual claimants on cash flows at $t=2$ and have limited liability. If the bank liquidates bad loans the

payoff to bank shareholders is $R(1-q)+R\lambda q-D$.[3] If the bank rolls over bad loans, the payoff to bank shareholders is $R-D$ if the bad loans perform and zero if they do not.

3.3.4 Bad loans

By liquidating bad loans we mean a decision with which the bank sacrifices a part of the outstanding claim for a higher probability of being repaid. This can represent several decisions such as: (i) the use of the material adverse change clause, which gives a bank the right to call a loan when the probability of repayment deteriorates significantly; (ii) not rolling over a loan when the maturity of the loan is shorter than the duration of the project funded by the loan; (iii) restructuring of a loan where the bank writes off a part of the outstanding amount to increase the probability of repayment. Liquidation parameter λ is the amount that the bank can collect per unit of liquidated loans. It is socially optimal to liquidate bad loans. Leaving them as they are is risky and has a lower expected payoff than the payoff from liquidation (and new lending), which is certain.[4]

$$pR < \lambda R \tag{1}$$

For simplicity it is assumed that the bank extracts all value from the firms to which it lends. The total amount collected from lending is then equal to the aggregate output. Despite the liquidation of bad loans being socially optimal, the bank may choose to roll them over if bank shareholders do not fully internalize the losses when bad loans fail. The bank chooses to liquidate bad loans if liquidation and subsequent lending to new firms brings a higher expected payoff to bank shareholders than does rolling over of bad loans. This is the case if (with $R_{roll\ over}$ being the outcome of rolled-over bad loans):

$$R(1-q)+R\lambda q-D > \mathrm{E}\left[\max\left(R_{roll\ over}-D,0\right)\right] \tag{2}$$

Computing the expected payoffs gives the liquidation incentive constraint:[5]

$$R(1-q)+R\lambda q-D > p(R-D) \tag{3}$$

If the liquidation incentive constraint (3) is not satisfied, the bank chooses to roll over bad loans.

---

[3] The payoff from liquidating bad loans is certain. Whenever the bank chooses to liquidate bad loans, this payoff has to be positive.

[4] The insights of the model would remain the same if good loans and new lending were risky but the variance of their repayment would be lower than the variance of bad loans that are rolled over.

[5] The incentive constraint only "bites" when debt obligations are so high that bank shareholders get zero in case bad loans fail. Note that for simplicity we assume that liquidation proceeds that are lent out again receive R with certainty. Assuming that a fraction q of those loans is likely to fail again makes no material difference to any of the results.

3.3.5 Equilibrium in stable times

The lending rate R, the proportion of bad loans q, the liquidation value λ and the probability that bad loans repay p are public knowledge at $t=0$. The analysis focuses on the case where parameter values are such that banking is only viable if bad loans are liquidated in stable times. We therefore assume that if the bank holds on to bad loans the total expected return from lending is less than 1:

$$R(1-q)+Rpq<1<R(1-q)+R\lambda q \tag{4}$$

Thus depositors and bank shareholders can both earn at least the risk free rate only if bad loans are liquidated. Therefore in equilibrium bad loans have to be liquidated. If bad loans are liquidated, the loan repayments at $t=2$ are certain. Hence, with the risk free rate being equal to 1, the promised repayment to depositors is equal to their initial investment $D=1-k$. To insure that bad loans are liquidated, the incentive constraint (3) has to be satisfied. It can be expressed as a constraint on the bank capital ratio k.

$$k>1-\frac{R\left(1-p-q\left(1-\lambda\right)\right)}{1-p} \tag{5}$$

The only way for the bank to commit to liquidate bad loans is to have a sufficiently high capital ratio. Since bank shareholders require a return strictly larger than the risk free rate, they have an incentive to increase bank leverage as much as possible, so in equilibrium the incentive constraint is binding. The required capital ratio is increasing in the proportion of bad loans q and decreasing in the liquidation value λ.

3.3.6 Banking crisis

Our focus is on ex-post intervention so we model a banking crisis as a zero-probability event as in Allen and Gale (2000). A banking crisis differs from stable times in that the proportion of bad loans turns out to be unexpectedly high. Neither the bank nor the depositors expect a shock to the amount of bad loans, so at $t=0$ their behavior is exactly the same as in stable times. But at $t=1$ the bank (and the regulator) observe that the proportion of bad loans is $q+\xi$, with $\xi>0$ being the shock. It still is socially optimal to liquidate bad loans and lend to new firms. But the incentive constraint is no longer satisfied for the new, higher proportion of bad loans. The new capital ratio k' that would satisfy the incentive constraint given the higher proportion of bad loans, is larger than the existing capital ratio k:

$$k' = 1 - \frac{R\left(1-p-(q+\xi)(1-\lambda)\right)}{1-p}$$

$$= 1 - \frac{R\left(1-p-q(1-\lambda)\right)}{1-p} + \frac{R\xi(1-\lambda)}{1-p} \qquad (6)$$

$$> k$$

Depositors recognize that the bank has been hit but do not observe the size of the shock. They cannot coordinate their actions. If all existing depositors withdraw, potential new depositors are not willing to lend to the bank either. Because the depositors do not know the size of the shock, a new deposit contract at a different rate is not feasible.[6] If the bank cannot obtain new deposits, it liquidates its loan portfolio at a rate λ to repay the existing deposits. If λ is less than the amount of debt $1-k$, depositors are not fully repaid. Whether $\lambda < 1-k$ depends on the equilibrium value of k; in what follows we will assume this to be the case.

The regulator, representing the central bank and the government, does observe the size of the shock. It cannot require the bank to liquidate bad loans but it can possibly improve total welfare by intervening the bank. Total welfare is defined as the sum of repayments to depositors, bank shareholders and the losses or gains realized by the regulator. In the absence of intervention, the entire bank is liquidated. The loans are then sold to outside investors. Depositors place the proceeds into riskless government securities. Total welfare is then equal to λ. This scenario implies efficiency losses because good loans are liquidated at a loss and because the proceeds from liquidation of loans are not lent on to new firms as the bank has gone out of business. Consider next two types of intervention, the first group directed at providing access to debt finance, and the second group focusing on recapitalization.

3.3.7 Deposit insurance, blanket guarantees and liquidity support

These measures prevent bank failures as the bank is able to obtain debt financing despite being insolvent. Because the incentive constraint is still not satisfied, the bank does not liquidate bad loans and gambles that they will succeed. Under deposit insurance or blanket guarantees on bank liabilities, the investors are willing to lend to the bank at the risk free rate because the regulator covers the difference between the value of bank assets $R(1-q-\xi)$ and the outstanding debt D in case bad loans fail. The expected loss of the regulator is $(1-p)\left(D-R(1-q-\xi)\right)$. By

[6] This assumption rules out equilibria where the deposit rate is adjusted for risk or where the bank shrinks. Such equilibria are only possible if the shock is small enough that bank shareholders can earn a positive return after readjustment.

providing liquidity support the regulator effectively substitutes all of the bank's existing debt. The expected repayment of the bank is $pD+(1-p)\big(R(1-q-\xi)\big)$. The expected loss to the regulator is exactly the same as under deposit insurance. Providing liquidity support or guaranteeing bank liabilities is a better outcome than the failure of the bank if the total expected repayment of the good loans and the bad loans that are rolled over is larger than the liquidation value of the entire bank, which is the case if:

$$pR+(1-p)R(1-q-\xi)>\lambda \tag{7}$$

If the amount of bad loans $q+\xi$ is too high (the shock too large), condition (7) is not satisfied and then guarantees on bank liabilities and liquidity support are worse than letting the bank fail at $t=1$.

3.3.8 Bank recapitalization

Bank shareholders do not have an incentive to recapitalize the bank at $t=1$ after it has been hit by a shock; recapitalization would only benefit the depositors. The regulator, however, can improve total welfare by recapitalizing the bank before the bank makes the decision about the bad loans. The incentive constraint of the bank can be satisfied if the regulator injects and amount of capital g into the bank, where g follows from:

$$k+g>1-\frac{R\big(1-p-q(1-\lambda)\big)}{1-p}+\frac{R\xi(1-\lambda)}{1-p} \tag{8}$$

The minimum amount of capital that satisfies this inequality is $\bar{g}=\frac{R\xi(1-\lambda)}{1-p}$. It is used to repay part of the existing deposits. Deposits in the second period are then only $1-k-g$. When the incentives for liquidating bad loans are restored, the value of bank assets at $t=2$ is $R(1-q-\xi)+R\lambda(q+\xi)$. This outcome maximizes total welfare for two reasons: (i) no good loans are liquidated (as would happen in the case of bank failure) and (ii) bad loans are liquidated (unlike what happens under the other type of interventions). The regulator can recoup the costs of the equity injection at $t=2$. In terms of total welfare it does not matter whether the regulator recoups more or less than g at $t=2$.

The recapitalization that we focused on in the preceding analysis satisfies three conditions. First, the recapitalization has to be done before the bank makes the decision about bad loans. If it is done after the bank has already rolled over the bad loans, it has no beneficiary effect on incentives: ex post recapitalization only covers the losses from failed bad loans. Second, the recapitalization needs to be large enough. We assume that the regulator cannot take

over the bank and thus cannot directly instruct the manager to liquidate bad loans. Therefore the recapitalization has to be high enough so that with $k+g$ of equity, liquidation of bad loans becomes in the interest of bank shareholders. Third, there should be a ban on dividend payouts. If existing bank shareholders could decide what to do with recapitalization funds they would prefer an immediate payout and a continued gamble with the bad loans. To be effective, the recapitalization has to reduce leverage enough to shift incentives, so it should be accompanied by a ban on dividend payments.

3.3.9 Macroeconomic Consequences

To tie these results to macroeconomic consequences we extend the model in a very simple, one way partial equilibrium manner. We assume that economic recovery is related to positive project outcomes and new investments. More in particular, expected future output in the context of our model equals:

$$\begin{aligned} \mathrm{E}y_Z &= R(1-q)+qpR \\ &= (1-q(1-p))R \end{aligned} \tag{9}$$

in case zombie banks prevail. But if incentives encourage liquidation and new lending, expected output becomes:

$$\begin{aligned} \mathrm{E}y_R &= (1-q)R+\lambda qR \\ &= (1-q(1-\lambda))R \end{aligned} \tag{10}$$

So the recovery gains from recapitalizing banks are:

$$\begin{aligned} \mathrm{E}y_R - \mathrm{E}y_z &= (\lambda - p)qR \\ &> 0 \end{aligned} \tag{11}$$

The inequality follows from equation (1).

3.3.10 Model summary and empirical predictions

We can summarize the model as follows. A bad loan is a highly risky project with an expected payoff lower than its liquidation value. Yet, it is attractive for a weakly capitalized bank: due to the limited liability the bank's shareholders capture the upside if the bad loans repays but shift the risk of losses to debtholders. On the aggregate level renewing bad loans results in lower output because inefficient firms are funded instead of productive new or expanding firms. In stable times, depositors correctly predict the proportion of bad loans that banks will realize. In equilibrium bank leverage is then such that banks have an incentive to liquidate bad loans. But in a banking crisis the ratio of bad loans turns out to be unexpectedly high. Banks that have

been hit no longer have an incentive to liquidate bad loans. If depositors expect a bank to be insolvent in the final period, they withdraw early causing the liquidation of the bank. If the bank is liquidated, there are efficiency losses as together with bad also good loans are liquidated. The regulator can improve welfare if it prevents bank failures and restores incentives of banks to liquidate bad loans. Recapitalizing banks before they make a decision about bad loans fulfills both objectives. Providing liquidity support or guaranteeing bank liabilities, however, only prevents bank failures but does not change their incentives for managing bad loans. The empirical prediction from the model is that bank recapitalizations improve welfare and lead to higher expected future output, which in our empirical analysis translates into shorter recession duration.

3.4 Empirical methodology

Our dataset is a panel of systemic banking crises where index i denotes a crisis and t refers to a particular quarter of a recession. For each crisis, the sample includes all quarters when the country was in a recession and the quarter in which it recovered. The time index t indicates how many quarters a recession has already lasted. In the first recession quarter $t = 0$. At the time of recovery $t = T_i$; the completed recession duration of a crisis i is T_i. We define y_{it} as an indicator of whether a country is in recession in a given quarter or it has just recovered.

$$y_{it} = \begin{cases} 1 & \text{recession ends} \\ 0 & \text{recession is ongoing} \end{cases}$$

In duration models the probability that a process ends is typically referred to as the hazard rate.[7] In our case the hazard rate is the probability that a recession ends in a particular quarter conditional on that it has not ended in any of the previous quarters and conditional on the values of explanatory variables x_{it} and a crisis specific fixed effect c_i. It is given by the following equation:

$$\lambda(t, x_{it}, c_i) = \Pr(y_{it} = 1 \mid y_{it-1} = 0, ..., y_{i1} = 0, x_{it}, c_i) = G(x_{it}\beta + \gamma_t + c_i) \tag{12}$$

where $G(\cdot)$ is a cumulative distribution function and $\gamma_t = \gamma(t)$ is a function of elapsed duration.

Crucial for our estimation approach is to control for crisis severity. One may expect that intervention measures in banking crises are endogenous to crisis severity. In more severe crises different measures may be used than in mild crises or the extent to which they are used may be correlated with severity. If intervention was completely determined by crisis severity,

[7] For additional discussion on modeling duration of a process see Online Appendix A, available at http://www.uva.nl/profile/t.homar.

identification of effects of intervention would not be possible. There is, however, likely to be some randomness in intervention, in particular with respect to its timing. To take advantage of that, we make some assumptions about the structure of crisis severity, which enable us to identify the effect of intervention. We assume crisis severity has two components: a time invariant crisis specific component c_i, which could be interpreted as the shock that has caused a banking crisis, and $\gamma_t = \gamma(t)$, which describes the pattern severity follows over time. If there is no intervention, c_i determines the initial level of probability of recovery and γ_t describes how the probability changes over time. Gradually the component γ_t offsets the shock and the recession ends. We expect γ_t to be an increasing function of time but not necessarily monotonically increasing. To allow for that we use a cubic specification $\gamma_t = \gamma_0 + \gamma_1 t + \gamma_2 t^2 + \gamma_3 t^3$. We let c_i be correlated with intervention measures, while γ_t is not crisis specific and is independent of intervention. Intuitively, this means that intervention measures depend on the shock that caused the banking crisis, but not on exogenous factors that affect the level of severity over time. The component c_i is a fixed effect in a duration model. To estimate a specification with fixed effects in a nonlinear model we use the approach of Mundlak (1978). For easier presentation of the approach, we restate equation (12) using y_{it} as an indicator of the latent probability of recovery in place of the hazard rate, with $y_{it} = 1\left[y_{it}^* > 0\right]$ and $1[....]$ being an index function that equals 1 if $y_{it}^* > 0$ and 0 otherwise.

$$y_{it}^* = x_{it}\beta + \gamma_t + c_i + e_{it} \tag{13}$$

Since c_i may be correlated to x_{it}, we specify the correlation explicitly as c_i being a function of the average values of explanatory variables over time within a crisis and a random component v_i

$$c_i = \bar{x}_i\delta + v_i \tag{14}$$

Then we include equation (14) into equation (13) to get:

$$y_{it}^* = x_{it}\beta + \bar{x}_i\delta + \gamma_t + v_i + e_{it}. \tag{15}$$

This transformation, proposed by Mundlak (1978), enables the estimation of a fixed effects model with a random effects procedure. It can be applied also to nonlinear models such as logit or complementary log-log models that are commonly used in duration analysis. The effects of variables of interest are described by the vector of coefficients β. In contrast, $\bar{x}_i\delta$ is a part of the fixed effect. The estimates of δ have no interpretation apart from that if they are not significantly different from zero, correlation is not problematic and a regular random effects specification could be used. The intuition for this approach is as follows. Crises differ in shock c_i. In each quarter the effect of intervention (if it is beneficial) works in the opposite direction

as the shock. An approach that would assume the shock is unrelated to intervention, would underestimate the size of the shock roughly by the size of the effect of intervention that is on average place in all periods of a crisis. Therefore it is crucial to separate the effect of intervention that is a part of the fixed effect, from the part that varies over time and on which estimates of β are based.

In the next step we use the estimated parameters from equation (15) to obtain predicted probabilities of recovery, which we then use to compute expected recession durations. The following equations describe predicted probabilities for three estimation models with different distributional assumptions: the complementary log-log (16), the logit (17) and the linear probability (18) model respectively:

$$\hat{P}\left(y_{it}=1 \mid y_{it-1}=0,...,y_{i1}=0,x_{it},c_i\right)=1-\exp\left(-\exp\left(x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t\right)\right) \tag{16}$$

$$\hat{P}\left(y_{it}=1 \mid y_{it-1}=0,...,y_{i1}=0,x_{it},c_i\right)=\frac{\exp\left(x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t\right)}{1+\exp\left(x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t\right)} \tag{17}$$

$$\hat{P}\left(y_{it}=1 \mid y_{it-1}=0,...,y_{i1}=0,x_{it},c_i\right)=x_{it}\hat{\beta}+\bar{x}_i\hat{\delta}+\hat{\gamma}_t \tag{18}$$

A desirable characteristic of the complementary log-log model is that it assumes that the underlying process (recession) is continuous but can only be observed at discrete points in time, while the logit or the linear probability model require the assumption that the duration process is discrete. Therefore we use the complementary log-log specification as our basic approach.[8] The probabilities given by the equations above are conditional on that the recession has not ended in any of the previous quarters and on x_{it} and c_i. Hence we refer to these probabilities as to conditional probabilities of recovery. In contrast, we use the term unconditional probability of recovery for the predicted probability of recovery that is conditioned only on the values of explanatory variables until then $X_{i[1...t]}$ and c_i but not on the recession not having ended before. The unconditional probability of recovery is the product of the probability of recovery conditional on recession lasting until t and the unconditional probability that the recession has not ended in the previous quarter.

$$P\left(y_{it}=1 \mid X_{i\{1,...,t\}},c_i\right)=P\left(y_{it}=1 \mid y_{it-1}=0,...,y_{i1}=0,x_{it},c_i\right)\cdot\left(1-P\left(y_{it-1}=1 \mid X_{i\{1,...,t-1\}},c_i\right)\right) \tag{19}$$

The unconditional probability that the recession has not ended in the previous quarter can be expressed as the corresponding conditional probability of that quarter (conditional on the recession not having ended the quarter before) and the unconditional probability of no recovery

[8] In robustness checks we report estimates based on the other two probability models. It is clear from that table that using alternative probability models does not materially change of the results.

a quarter before. This procedure can be repeated all the way back to the first quarter when the conditional probability of recovery is equal to the unconditional probability as there is no preceding quarter. This gives an expression for the unconditional probability of recovery in quarter t as a product of conditional probabilities of no recovery in all previous quarters.

$$P\left(y_{it}=1 \mid X_{i\{1,\dots,t\}}, c_i\right)=P\left(y_{it}=1 \mid y_{it-1}=0,\dots,y_{i1}=0, x_{it}, c_i\right)\cdot \\ \cdot\left(1-P\left(y_{it-1}=1 \mid y_{it-2}=0,\dots,y_{i1}=0, x_{it-1}, c_i\right)\right)\cdot\dots\cdot\left(1-P\left(y_{i1}=1 \mid x_{i1}, c_i\right)\right) \quad (20)$$

The expected recession duration $E\left[T_i\right]$ is the product of the predicted unconditional probabilities of recovery in any period and their respective durations, which range from $t=0$ up to $t=t_{MAX}$.

$$E\left[T_i\right]=\sum_{t=1}^{t_{MAX}}\left[t\cdot\hat{P}\left(y_{it}=1 \mid x_{i\{1,\dots,t\}}, c_i\right)\right] \quad (21)$$

The limit t_{MAX} is set at a value where the numerically computed probability of recession lasting until then is equal to zero.

3.5 Data

The dataset covers 68 systemic banking crises from the period 1980 to 2013, of which 40 are from the period before 2007 and 28 belong to the recent global financial crisis. For each banking crisis the panel includes the quarters in which a country was in a recession, and the quarter when it recovered.[9] We start with the list of 65 systemic banking crises described by Laeven and Valencia (2012b). They consider a banking crisis to be systemic if two conditions are met. Firstly, there is major distress in the banking system such as bank runs, large losses of bank capital and bank liquidations. Secondly, there need to be significant policy interventions in response to the problems in the banking sector. This condition is met if at least 3 of the following measures were used:

- extensive liquidity support (claims of the central bank on deposit money banks larger than 5 percent of deposits and liabilities to nonresidents);
- gross bank restructuring costs at least 3 percent of GDP;
- significant bank nationalizations;
- significant guarantees on bank liabilities;

[9] Exceptions are Cyprus and the second crisis in Greece where the recessions were still ongoing in 2013 Q3, which was the last available observation. For these two crises the sample includes only recessionary quarters and no recovery quarter.

- asset purchases amounting to at least 5 percent of GDP;
- deposit freezes or bank holidays.

Table 1: Systemic banking crises in the period 1980 to 2007.

Country	Crisis start	Systemic crisis date	Recession start	Recovery	Recess. duration	Duration of exist. recession	Bank restruct. date	Recap. end of recession	Recap. end of crisis
Argentina	1980 Mar	1980 May	1981 Q1	1983 Q1	8				
Argentina	1989 Dec	1989 Dec	1988 Q1	1990 Q3	10	7			
Argentina	1995 Jan	1995 Jan	1995 Q1	1995 Q4	3				
Argentina	2001 Nov	2001 Dec	2001 Q2	2002 Q2	4	2			
Bolivia	1994 Nov	1994 Nov							
Brazil	1990 Feb	1990 Feb	1990 Q1	1991 Q1	4				
Brazil	1994 Dec	1994 Dec	1995 Q2	1995 Q4	2				1.24
Bulgaria	1996 Jan	1996 Jun	1989 Q1	1998 Q1	36	28	1996 Q2	4.50	4.50
Chile	1981 Nov	1983 Mar	1981 Q4	1983 Q1	5				
Colombia	1982 Jul	1982 Jul							
Colombia	1998 Jun	1998 Jun	1998 Q3	1999 Q3	4			0.38	0.75
Cote d'Ivoire	1988	1988							
Croatia	1998 Mar	1998 Mar	1998 Q1	1999 Q3	6			2.40	8.37
Czech Republic	1996 Jun	1996 Jun	1996 Q4	1997 Q4	4				
Dominican Rep.	2003 Apr	2003 Apr	2003 Q1	2004 Q1	4	1			
Ecuador	1998 Aug	1998 Dec	1998 Q3	1999 Q4	5		1999 Q3	5.85	5.85
Estonia	1992 Nov	1992 Nov	1994 Q1	1995 Q2	5				
Finland	1991 Sep	1993 Feb	1990 Q2	1993 Q3	13	5	1992 Q4	2.89	3.46
Ghana	1982 Jan	1982 Jan	1982 Q1	1984 Q1	8				
Indonesia	1997 Nov	1997 Dec	1997 Q4	1999 Q3	7			20.10	58.14
Jamaica	1996 Dec	1997 Feb	1997 Q3	1998 Q2	3			1.51	1.51
Japan	1997 Nov	1997 Nov	1997 Q4	1998 Q3	3			0.15	0.75
Korea	1997 Aug	1997 Nov	1997 Q4	1998 Q3	3			0.87	3.33
Latvia	1995 Apr	1995 Apr							4.54
Lithuania	1995 Dec	1995 Dec							
Malaysia	1997 Jul	1998 Mar	1998 Q1	1999 Q1	4			0.58	1.18
Mexico	1994 Dec	1995 Jan	1995 Q1	1995 Q3	2			1.65	4.98
Nicaragua	2000 Aug	2001 Jan							
Norway	1990 Dec	1991 Oct	1991 Q3	1993 Q1	6		1991 Q4	3.08	3.08
Paraguay	1995 May	1995 Jul							
Philippines	1997 Jul	1998 Mar	1997 Q3	1998 Q4	5				
Russia	1998 Aug	1999 Jan							
Sri Lanka	1989	1989							
Sweden	1991 Sep	1992 Sep	1991 Q1	1993 Q1	8	2	1992 Q2	3.26	5.31
Thailand	1997 Jul	1997 Oct	1997 Q3	1998 Q4	5		1998 Q3	4.17	5.30
Turkey	2000 Nov	2000 Dec	2000 Q4	2002 Q1	5				2.64
Ukraine	1998 Aug	1998 Dec	1998 Q1	1999 Q1	4	2			
Uruguay	2002 Jan	2002 Apr	1999 Q1	2003 Q1	16	12		0.33	0.38
Venezuela	1994 Jan	1994 Jan	1994 Q1	1995 Q1	4		1994 Q2	24.61	24.61
Vietnam	1997 Nov	1998 Oct							

CRISIS START is the date when major distress in the banking sector was observed. SYSTEMIC CRISIS DATE is the date when the conditions for a banking crisis to be classified as systemic were met. RECESSION DURATION is in quarters. DURATION OF EXISTING RECESSION tells how long a recession has already been ongoing at the time of the banking crisis start. BANK RECAPITALIZATION DATE is the time when the main part of bank recapitalizations has been completed. It is only reported if this happened before the end of the recession and the recapitalizations were not very small. RECAP. END OF RECESSION is the cumulative amount of bank recapitalizations at the end of the recession. RECAP. END OF CRISIS is the total amount of bank recapitalizations in a banking crisis (it includes also bank recapitalizations after the recession has already ended). The recapitalization amounts are expressed in percent of total banking assets.

When both conditions are met a crisis is considered systemic. If just 2 types of measures from the list above were used, Laeven and Valencia (2012b) report it as a borderline case. All crises in the 1980 to 2007 period listed in their dataset were systemic according to the above definition. In the recent global financial crisis 17 countries were classified as having a systemic banking crisis and 8 as borderline cases.

Table 2: Systemic banking crises in the period 2007 to 2013.

Country	Crisis start	Systemic crisis date	Recession start	Recovery	Recess. duration	Duration of exist. recession	Bank restruct. date	Recap. end of recession	Recap. end of crisis
Austria	2008 Sep	2008 Dec	2008 Q3	2009 Q3	4		2009 Q2	1.10	1.46
Belgium	2008 Sep	2008 Oct	2008 Q3	2009 Q2	3		2008 Q4	2.81	4.27
Cyprus	2011 Jul	2013 Mar	2011 Q3		7		2013 Q1	17.86	17.86
Denmark	2008 Sep	2009 Feb	2008 Q3	2010 Q1	6		2009 Q2	1.22	1.34
France	2008 Sep		2008 Q2	2009 Q3	5	1		0.56	0.85
Germany	2008 Sep	2009 Oct	2008 Q2	2009 Q2	4	1	2009 Q1	0.81	1.35
Greece	2008 Sep	2009 May	2008 Q2	2009 Q2	4	1			1.27
Greece	2010 Apr	2012 May	2010 Q1		13	1	2012 Q2	6.86	6.86
Hungary	2008 Sep		2008 Q3	2009 Q4	5			0.15	0.15
Iceland	2008 Sep	2008 Oct	2008 Q3	2010 Q4	9		2009 Q4	11.13	11.13
Ireland	2008 Sep	2009 Jan	2008 Q1	2011 Q1	12	2	2010 Q4	9.52	14.30
Italy	2008 Sep		2008 Q2	2010 Q1	7	1		0.20	0.28
Kazakhstan	2008 Sep	2010 Sep							4.10
Latvia	2008 Sep	2008 Dec	2008 Q1	2009 Q4	7	2		2.01	6.67
Luxembourg	2008 Sep	2008 Sep	2008 Q2	2009 Q3	5	1	2008 Q4	0.92	0.95
Mongolia	2008 Sep	2009 Nov	2009 Q1	2010 Q1	4				2.49
Netherlands	2008 Sep	2008 Oct	2008 Q4	2009 Q3	3		2008 Q4	0.93	1.47
Nigeria	2009 Aug	2011 Oct							4.16
Portugal	2008 Sep		2008 Q1	2009 Q2	5	2			2.36
Russia	2008 Sep		2008 Q3	2009 Q3	4		2009 Q2	1.02	1.02
Slovenia	2008 Sep		2008 Q3	2009 Q3	4				1.95
Spain	2008 Sep	2011 Apr	2008 Q2	2010 Q1	7	1		0.06	0.36
Spain	2011 Sep	2012 Dec	2011 Q3	2013 Q3	8		2012 Q4	2.48	2.48
Sweden	2008 Sep		2008 Q1	2009 Q4	7	2			
Switzerland	2008 Sep		2008 Q4	2009 Q3	3			0.31	0.31
Ukraine	2008 Sep	2009 May	2008 Q2	2009 Q2	4	1		3.23	7.31
United Kingdom	2007 Sep	2008 Nov	2008 Q2	2009 Q4	6			0.53	0.97
United States	2007 Dec	2008 Oct	2008 Q1	2009 Q3	6		2008 Q4	1.35	1.36

For explanations of the column headings see Table 1.

The starting date of a banking crisis is the quarter in which major distress in the banking sector was observed. The date when a crisis becomes systemic is the quarter when the above conditions are fulfilled. Using these criteria, we add 3 more crisis to the list: Cyprus starting in 2011 Q3, Greece 2010 Q2 and Spain 2011 Q3. Greece and Spain already experienced a banking crisis in 2008 Q3. The recessions immediately following the 2008 crisis had already ended by the time problems in the banking sector reemerged. We analyze the first and the second crises of these two countries separately as there were two recessions and multiple rounds of intervention measures during both recessions. Table 1 lists the systemic banking crises from the period 1980 to 2007. Countries that experienced a systemic banking crisis (or were classified as

a borderline case) during the recent global financial crisis are listed in Table 2. Some banking crises were not followed by a recession. These crises are included in the tables although they cannot be analyzed with recession duration models. In total there are 13 such crises, 11 in the period before 2007 and 2 after. Next we describe the variables used in the regression analysis.

3.5.1 The Recession indicator

The recession indicator is the dependent variable in the duration models. It is equal to 0 if a country is in a recession in a given quarter and equal to 1 if it has just recovered from it. For countries that are not in a recession at the time of the banking crisis start, the start of the recession is defined as the first quarter with negative GDP growth after the start of the banking crisis. This quarter needs to be either part of a sequence of at least two consecutive negative growth quarters or a sequence of positive and negative quarters where a positive quarter is always preceded and succeeded by a negative quarter and there are at least two consecutive negative quarters in that sequence. The recession needs to start at latest 6 quarters after the start of a banking crisis to be considered related to the banking crisis.[10] Two consecutive positive growth quarters mark the end of a recession. The first of these two quarters is the recovery quarter in which the recession indicator turns 1. The recession period is composed of quarters with negative growth but may include few positive growth quarters within the sequence of negative growth quarters.[11] Such a definition is used as one positive growth quarter does not mean that a recession is really over. Applying this definition to determine the start and end of the recent recession in the US gives the same dates as the ones announced by the National Bureau of Economic Research. NBER (2012) uses multiple indicators and judgment to define the date of a peak and a through. A recession is the period between a peak and a through. The recent recession in the US began with the peak in December 2007 and ended with the through in June 2009. In the first quarter of 2008 GDP growth was negative; in the second it was positive; then four quarters of negative growth followed. The recovery quarter was the third quarter of 2009. Some countries are already in a recession in the quarter when the banking crisis starts. In these cases the negative growth quarters before the start of the banking crisis are

[10] The recession in Cote d'Ivoire started 2 years after the start of the banking crisis. The primary reason of this recession was not the banking crisis therefore we do not include it into the sample. All other recessions started at latest 5 quarter after the banking crisis start.

[11] In the robustness section we estimate the model using a definition where only consecutive negative growth quarters are counted as a recession, with similar results.

counted as a part of the recession.[12] The sources of GDP data are the World Economic Outlook and the International Financial Statistics databases (IMF 2013a; IMF 2013b).[13]

3.5.2 Bank recapitalizations

The variable bank recapitalizations measures the cumulative amount of recapitalizations in the banking sector since the start of the crisis. The amounts are weighed by total assets of the banking sector. Recapitalizations are assumed to have an effect on the probability of recovery from the first quarter after they have been implemented until the end of the recession.

There is a variety of measures that could be considered a recapitalization. We count as recapitalization injections of common equity, preferred stock, conditionally convertible bonds or any Tier 1 qualifying instrument by the state, a bank restructuring agency or other government agency. We do not consider injections of subordinated debt, qualifying as Tier 2 capital, a recapitalization. Conversion of subordinated debt or other bank liabilities into equity and liability management exercises are counted as recapitalization. Write-offs of bank liabilities in the process of bank restructuring where creditors do not get any security in exchange are not counted as recapitalization although they are sometimes referred to as the contribution of bondholders toward recapitalization. In purchase and assumption deals the state often compensates the acquiring bank for the difference between the value of assets and liabilities of the bank that is being taken over in the process of restructuring. This amount is not counted as recapitalization as it merely brings the net asset value of the restructured bank to zero. It benefits the creditors of the distressed bank that would otherwise suffer losses in the process of restructuring and does not increase capital of the acquirer. If the acquiring bank receives an equity injection on top of that, the equity injection is counted as recapitalization. Sometimes both the state and private investors participate in bank equity issues. In those cases only the amount purchased by the state is counted as recapitalization.

We collect the data about bank recapitalizations from four types of sources: IMF staff reports, European Commission decisions about state aid, webpages of central banks, restructuring agencies and annual reports of intervened banks. We need the total amount of recapitalizations in the banking sector in each quarter for all crises. Whenever possible we collect the recapitalization amounts at bank level. We document the amount of recapitalization, a

[12] Only the consecutive negative growth quarters that run up to the start of the banking crisis are counted as an existing recession. The pre-banking crisis period with alternating growth rates is not counted as a recession.

[13] For more details about the data see Online Appendix B. GDP data sources, available at http://www.uva.nl/profile/t.homar.

description of the measure and the month or quarter when the measure was implemented. For the recent crises almost all data has this level of detail. If bank-level data is not available, we collect data about total amount of recapitalizations in each quarter of a recession. For some crises before 2007 IMF staff reports only include how much was spent on recapitalizations until a certain date. In such cases we use two rules how to allocate the amounts across the quarters. If the names of banks or the number of banks intervened in a particular quarter are reported but not the amounts per bank, we assume that each of the intervened bank received an equal amount. If only the date when a bank restructuring program was approved by the government and the total amount of recapitalizations at a later point in time are known, we assume that recapitalization amounts are evenly spread across quarters between the start of the restructuring program and the time at which the cumulative amount of recapitalizations is reported. Table 1 and Table 2 provide data about the amount of bank recapitalizations in banking crises. For a complete list of recapitalizations with short descriptions see Appendix on page 133.

In some regressions we use an indicator for bank recapitalizations, which turns from 0 to 1 in the quarter after the following two conditions are satisfied:

- The cumulative recapitalizations since the start of the crisis exceed half of the amount of recapitalizations in the whole banking crisis (which includes recapitalizations after the recession has already ended).
- The cumulative recapitalizations exceed the threshold to be considered significant. This limit is 0.75% of total banking assets for 2007 to 2013 crises and 1.75% of total banking assets for 1980 to 2007 crises. It is 50% of the median total amount of recapitalizations in banking crises where there were some recapitalizations.

The first condition is to determine the time when the main part of bank recapitalizations has been implemented. The second is necessary not to treat crises with very little recapitalizations as having done a proper bank restructuring.

3.5.3 Guarantees on bank liabilities

We use an indicator for the presence of significant guarantees on bank liabilities other than deposits. The indicator takes value 1 if guarantees were present in the preceding quarter. The lag is used in order to allow some time for the guarantees to have an effect on GDP growth. We use the data of Laeven and Valencia (2012b) about the introduction and removal dates of significant guarantees on bank liabilities and complement it with data from European Commission decisions about state aid. The indicator for guarantees on bank liabilities in quarter t is equal to 1 if the guarantees were in place in the preceding quarter. The lag is used in order

to allow some time for the guarantees to have an effect on GDP growth. The variable values are based on the dates of introduction of blanket guarantees and dates of removal reported in (Laeven and Valencia 2012a) and documents of the European Commission about state aid decisions where the guarantee schemes requested by member states are approved.[14]

3.5.4 Liquidity support, monetary and fiscal policy

The measure for liquidity support provided by central banks is the ratio of claims of monetary authorities on deposit money banks to total deposits, computed from end of quarter values lagged by one period. For monetary policy, we use two alternative measures. The preferred proxy, available for crises after 2007, is the decrease in real interest rates from quarter $t-2$ to $t-1$ (when the probability of recovery in quarter t is analyzed). In the analysis of crises before 2007 and of the full sample we employ the quarterly growth rate in reserve money as a proxy for monetary policy not to lose observations because interest rate data is not available for all pre-2007 crises. We control for the effect of fiscal policy by using the cyclically adjusted general government deficit, which is available for most of the crises after 2007 but very few crises before 2007. The source of data for liquidity support and monetary policy is the International Financial Statistics database (IMF 2013b) and for fiscal policy the World Economic Outlook Database (IMF 2013a).[15]

3.6 Results

We estimate the effect of bank recapitalizations, guarantees on bank liabilities, liquidity support, monetary policy and fiscal policy on the probability of recovery from recessions related to banking crises. The dependent variable is the recession indicator, which equals 1 if a recession has just ended and 0 otherwise. The explanatory variables are of three types. First, there are variables describing intervention. A positive estimated coefficient means that a higher value of the explanatory variable increases the probability of recovery. Second, there are averages of intervention variables, averaged over all time periods of a recession. Including the averages enables us to estimate a duration model with fixed effects, which are necessary to control for the correlation between the time invariant component of crisis severity and intervention. Third,

[14] For details see Online Appendix C. Data about guarantees on bank liabilities, available at http://www.uva.nl/profile/t.homar.

[15] For details see Online Appendix D. Data about liquidity support, monetary policy and fiscal policy, available at http://www.uva.nl/profile/t.homar.

Table 3: Estimation results of the effects of intervention variables on the probability of recovery for the full sample of crises and the subsamples from the periods 1980 to 2007 and 2007 to 2013.

Recession indicator	Full sample 1980-2013 (1)	Past crises 1980-2007 (2)	Recent crises 2008-2013 (3)	Recent crises 2008-2013 (4)
Bank recapitalizations	0.6637***	1.2636***	1.0449**	1.5126**
	(3.26)	(2.72)	(2.18)	(2.01)
Guarantees on bank liabilities	0.0133	-2.4110	0.3519	0.2769
	(0.02)	(-1.61)	(0.39)	(0.22)
Liquidity support	2.6676*	4.2064	-4.5830	-3.6067
	(1.76)	(1.47)	(-1.26)	(-0.80)
Growth of reserve money	-0.7330	-1.1811	-1.3611	
	(-1.56)	(-1.39)	(-1.21)	
Real interest rate reduction				0.2528*
				(1.89)
Fiscal deficit, cyclically adj.				0.2077
				(0.97)
Average of bank recapitalizations	-1.2208***	-2.0501***	-2.6339**	-3.2815**
	(-2.96)	(-2.63)	(-2.40)	(-1.97)
Average of guarantees on bank liab.	-0.2616	3.8550*	-2.2861	-2.3825
	(-0.29)	(1.94)	(-1.29)	(-1.19)
Average liquidity support	-3.1950	-2.1699	4.9049	2.3497
	(-1.46)	(-0.69)	(1.13)	(0.42)
Average reserve money growth	0.2569	0.1703	3.0066	
	(0.48)	(0.27)	(1.10)	
Average real interest rate reduction				-0.7642***
				(-2.90)
Average cyclically adj. fisc. def.				-0.2598
				(-0.97)
Duration	2.9566***	10.5926**	1.8332	1.5191
	(2.97)	(2.56)	(1.24)	(0.79)
Duration^2	-0.3936**	-2.1770**	-0.1576	-0.0479
	(-2.35)	(-2.46)	(-0.65)	(-0.14)
Duration^3	0.0147*	0.1419**	0.0034	-0.0044
	(1.76)	(2.39)	(0.28)	(-0.22)
Constant	-7.1750***	-17.5565***	-5.3922**	-5.1440
	(-3.96)	(-2.84)	(-1.97)	(-1.58)
Observations	317	147	170	170
Crises	51	26	25	25
Log likelihood	-89.7512	-37.4357	-39.5122	-35.8520

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

a linear, quadratic and cubic term of elapsed duration are included to flexibly account for the dependence of probability of recovery on the time that a recession has already lasted.

Table 3 reports the results estimated on three samples: the full sample of systemic banking crises from 1980 until 2013, and separately for the subsample of past crises from the period 1980 to 2007 and the subsample of recent crises. The samples include crises in which the recession began up to 2 quarters before the start of the banking crisis. The start of the banking crisis is defined as the quarter when major distress in the banking sector was observed. Crises that did not have a recession or crises where the country was already in a recession for more than 2 quarters before the banking crises started, are not included. This cutoff is used to exclude recessions where the problems in the banking system are not an important determinant of the probability of recovery for a large part of recession duration. In Section 6 below, where we check the results for robustness, we present alternative specifications that also include crises with long recessions before the banking crises. This does not affect the results materially.

The estimates of the effect of bank recapitalizations on the probability of recovery are positive and significant in all samples: bank recapitalizations significantly increase the probability of recovery. Guarantees on bank liabilities on the other hand do not have a significant effect, while liquidity support is marginally (at a 10% level) significant only in the full sample; in both subsamples separately it is insignificant. The estimates for growth of reserve money are negative and insignificant. We use growth in reserve money as a proxy of monetary policy in order to be able to perform the analysis on the maximum possible number of crises. However, when we substitute it with the reduction in real interest rates in column (4), the estimated effect is positive and significant, albeit only marginally so, at 10%. The effect of fiscal policy approximated by the cyclically adjusted fiscal deficit is not significant.

Coefficients of *averages* of bank recapitalizations, guarantees on bank liabilities and real interest rate reduction are statistically significant for at least one sample, which confirms that policies are correlated to unobserved heterogeneity hence including their per crisis average values is necessary to obtain consistent estimates of the coefficients of interest. We stress, that the coefficients on averages should not be interpreted as a part of the effect of policies on the probability of recovery. They are only a component of the fixed effect in the model specification. Time dependence seems to be stronger and more significant in past crises than in recent crises. The coefficient of the linear duration is positive, so the longer a recession has already lasted, the more likely it is to end in the current quarter. The quadratic term is negative, so the marginal effect of duration on exit probability decreases as crises last longer. In other words, recessions that have already lasted some time are likely to be long, so the probability of recovery is

decreasing in the square of the duration (the marginal effect decreases linearly in crisis severity). But every recession ends at some point, so the effect of the cubic term is positive.

In many crises, recapitalizations are done at multiple times but with the largest amounts typically concentrated in one quarter. To approximate this we rerun the regressions with an alternative definition of bank recapitalization: we replace the continuous recapitalization variable with the bank recapitalization indicator, which loosely speaking equals one when a significant bank recapitalization took place; for a more precise definition see Section 4. If there were only minor recapitalizations, the value of the indicator is zero. Table 4 reports the results of the regressions of Table 3 but performed with the indicator instead of the continuous bank recapitalization variable.

The basic results are again confirmed: bank recapitalizations are the intervention with the most significant effect. To investigate the size of their effect on recession duration, we compute expected recession durations for two representative crises: a crisis representing the group of crises where substantial recapitalizations were done and a crisis representing the group with no or very little recapitalizations. The reason for introducing two representative crises is that the two groups of crises differ in unobserved crisis severity. Banking crises where banks were recapitalized tended to be much more severe than those where recapitalizations were not done. We use the expression *severe representative crisis* to denote the representative crisis of the group with significant bank recapitalizations and *mild representative crisis* to refer to the representative crisis of the group with no or minor recapitalizations. We compute expected recession duration with and without bank recapitalization for both representative crises. The expected durations are computed using equations (16), (20) and (21). The inputs for conditional probabilities of recovery are the estimated coefficients from Table 4 and the values of explanatory variables of the two representative crises. The explanatory variable values of the severe (mild) representative crisis are simply the averages of explanatory variables of crises where bank recapitalizations were (were not) done. The only explanatory variables of representative crises that are not averages and are not constant in all time periods of a representative crisis are the elapsed duration, which increases every quarter, and bank recapitalization indicator which changes from 0 to 1 in the quarter after bank recapitalization is done. The median time that the recession has already lasted when bank recapitalizations were done is 1 quarter in the past crises and 2 quarters in the recent crises. When computing the expected durations we assume that bank recapitalization is done at $t = 2$ and has an effect on the probability of recovery from $t = 3$ onwards.

Table 4: Estimation results of the effects of intervention variables on the probability of recovery for the full sample of crises and the subsamples from the periods 1980 to 2007 and 2007 to 2013. Bank recapitalization indicator is used as a measure of bank recapitalizations.

	Full sample 1980-2013	Past crises 1980-2007	Recent crises 2008-2013	Recent crises 2008-2013
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**
Bank restructuring	2.5108***	2.4613**	3.1409**	2.6437**
	(3.33)	(2.13)	(2.31)	(2.01)
Guarantees on bank liabilities	0.1880	-2.4368	0.9789	0.8003
	(0.37)	(-1.46)	(1.19)	(0.80)
Liquidity support	1.5768	2.7520	0.4888	0.0719
	(1.09)	(1.02)	(0.16)	(0.02)
Growth of reserve money	-0.6270	-1.0170	-1.3002	
	(-1.25)	(-1.21)	(-1.19)	
Real interest rate reduction				0.1525
				(1.60)
Fiscal deficit, cyclically adj.				0.1431
				(0.86)
Average of bank restructuring	-5.2089***	-4.9578**	-5.2014	-2.5858
	(-2.79)	(-2.00)	(-1.49)	(-0.74)
Average of guarantees on bank liab.	-0.7037	3.5793	-3.6670**	-2.3402
	(-0.85)	(1.64)	(-2.07)	(-1.35)
Average liquidity support	-2.6088	-1.3133	-3.8338	-7.5598
	(-1.25)	(-0.44)	(-0.79)	(-1.37)
Average reserve money growth	0.2661	0.0333	1.8759	
	(0.50)	(0.05)	(0.64)	
Average real interest rate reduction				-0.7108***
				(-2.88)
Average cyclically adj. fisc. def.				-0.2626
				(-1.30)
Duration	2.5049***	8.6194**	1.5378	2.2927
	(2.88)	(2.41)	(1.13)	(1.44)
Duration^2	-0.3177**	-1.7740**	-0.1267	-0.2011
	(-2.20)	(-2.25)	(-0.57)	(-0.82)
Duration^3	0.0118*	0.1184**	0.0031	0.0069
	(1.65)	(2.16)	(0.29)	(0.61)
Constant	-6.3985***	-14.5225***	-4.7048*	-6.8388**
	(-4.01)	(-2.79)	(-1.84)	(-2.12)
Observations	317	147	170	170
Crises	51	26	25	25
Log likelihood	-92.7037	-42.8870	-39.8077	-35.4818

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATION INDICATOR denotes significant bank recapitalizations. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

We emphasize that the explanatory variable average of bank recapitalization indicator (not to be confused with the bank recapitalization indicator), is by definition constant over all time periods. This enables us to analyze the effect of bank recapitalization independent from crisis severity by changing the value of the bank recapitalization indicator while keeping the component correlated to crisis severity fixed. For the mild representative crisis the value of this component is equal to 0 in all time periods. For the severe representative crisis the value of the component is positive.

Table 5: Expected and average observed recession durations for severe and mild crises.

	Full sample 1980-2013 (1)	Past crises 1980-2007 (2)	Recent crises 2008-2013 (3)	Recent crises 2008-2013 (4)
Severe crises				
Average observed duration	*6.18*	*5.60*	*6.42*	*6.42*
Expected duration without bank recapitalization	13.25	7.14	20.88	10.97
Expected duration with bank recapitalization	4.54	3.77	5.89	6.34
Difference in expected duration	8.72	3.37	14.99	4.63
Mild crises				
Average observed duration	*4.74*	*4.43*	*5.23*	*5.23*
Expected duration without bank recapitalization	5.25	4.50	5.80	5.59
Expected duration with bank recapitalization	3.03	2.98	3.10	3.53
Difference in expected duration	2.22	1.52	2.70	2.06

Severe crises are crises where significant bank recapitalizations are done at some point. Mild crises are crises where significant bank recapitalizations where never done. Average observed duration is the average recession duration of the group of crises to which a representative crisis refers. Expected recession durations are computed based on estimates from Table 4. The expected durations in each column correspond to estimates in the same column of Table 4 (i.e. the results reported in column (4) of Table 5 are based on the regression reported in column (4) of Table 4 etc.). Expected durations with bank recapitalization are computed assuming that bank recapitalization is done in the third recession quarter.

Table 5 reports the expected durations computed based on estimates from Table 4. Column (1) of Table 5 refers to column (1) of Table 4 etc. The size of the effect of bank recapitalization becomes apparent when the expected recession durations are compared. For the sample of 2007 to 2013 crises in column (4) the expected duration of severe representative crisis with bank recapitalization is fairly close to the average observed duration of severe crises; similarly the average observed duration of mild crises is close to the expected recession duration of the mild representative crises if bank recapitalization is not done. So our benchmarks seem well chosen. The counterfactual durations, however, are very different. The severe representative crisis would last 11 quarters instead of 6.3 quarters if bank recapitalization would not have been done. The expected recession of the mild representative crisis is reduced from

5.6 to 3.5 quarters if bank recapitalization is done. So on average bank recapitalization reduces expected recession duration by about 40%.

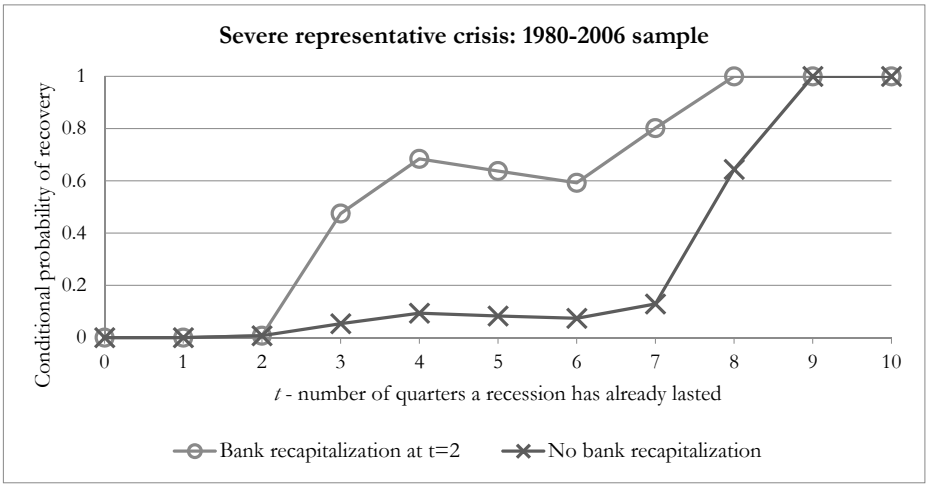


Figure 2: Predicted conditional probabilities of recovery for severe representative crisis of the 1980 to 2007 sample.

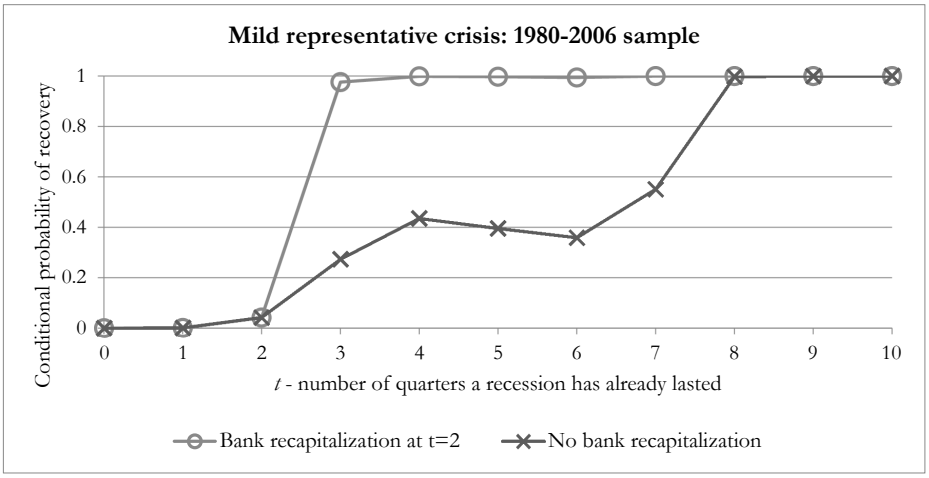


Figure 3: Predicted conditional probabilities of recovery for mild representative crisis of the 1980 to 2007 sample.

Another way of translating the regression results into an understandable metric is a comparison of exit probabilities over time with and without recapitalizations. Once again we do this for severe and mild crises, as defined earlier. We plot the predicted conditional probabilities, the same that were used to compute expected durations for past crises in column (2) and for the recent crises in column (4) of Table 5. We present the graphs of subsamples separately.[16] In the plots below we show the predicted exit probabilities with and without intervention.

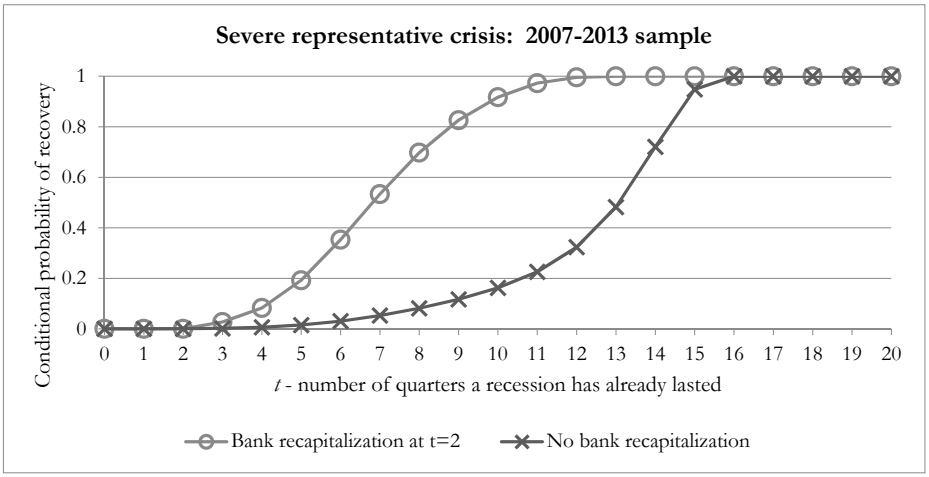


Figure 4: Predicted conditional probabilities of recovery for severe representative crisis, the 2007 to 2013 sample.

Initially, when a recession starts at $t=0$, the predicted probability of recovery is very low, then it gradually increases as time goes by. At some point the curve flattens or even slightly decreases (the 1980 to 2007 representative crises), but eventually it approaches 1: even without intervention, recessions at some point come to an end. The shape of the curve is due to time dependence, which is captured by the duration terms in regression specification (15). We implement the bank recapitalization at $t=2$, which explains the jumps in the plots at $t=3$.[17] In

[16] The reason is that the estimates on the sample of recent crises with real interest rates and fiscal policy are preferable. Also according to the likelihood ratio test pooling of the two subsamples should not be done. We test whether the null-hypothesis that the estimates on the full sample in column (1) of Table 3 (or Table 4) are not significantly different from the estimates on the subsamples in columns (2) and (3). The test statistic is $D = -2lnL_{Full\ sample} + 2lnL_{Past\ crises} + 2lnL_{Recent\ crises}$; degrees of freedom are equal to the number of constraints, which equals the number of explanatory variables. The *p*-value of the test with estimates from Table 3 is 0.0122 and with those from Table 4 it is 0.0667. Thus regressions should be run on the two subsamples separately.

[17] The absolute difference in the probability of recovery with and without bank recapitalization is widening also after *t=3* although then there is no change in policy anymore. The reason is that the change of bank recapitalization indicator happens within the cumulative distribution function so the shift in the predicted probability is not linear.

the absence of intervention the shock that caused the banking crisis and time dependence determine the time pattern of exit probabilities and the expected duration as becomes clear by comparing the no-intervention exit probabilities in the plots for the mild and the severe crisis respectively. The exit probabilities derived from the estimates based on the more recent subsample give qualitatively similar results: both for severe and mild crises, bank recapitalization significantly reduces expected recession durations (Figure 4 and Figure 5). The plots demonstrate our earlier results very clearly: bank recapitalizations increase the probability of recovery substantially.

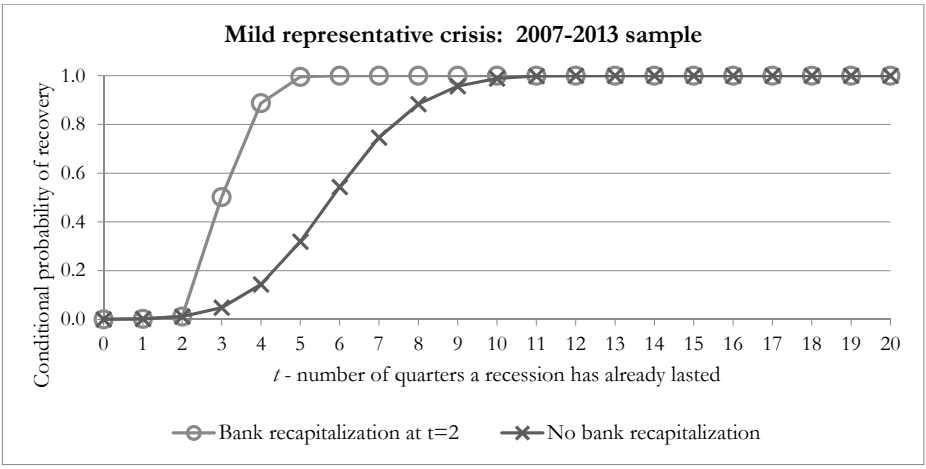


Figure 5: Predicted conditional probabilities of recovery for mild representative crisis of the 2007 to 2013 sample.

Finally, we investigate possible *interaction effects* between bank recapitalizations and other policies on the sample of recent crises. The results are reported in Table 6. When interactions terms are included individually, the interaction of guarantees on bank liabilities with bank recapitalizations and fiscal policy with bank recapitalizations are negative and significant. However, when all interaction terms are included simultaneously, their signs do not change but significance levels are much reduced, in fact no interaction term is significant in column (6) of Table 6. In all variants the basic impact of bank recapitalizations remains highly significant. The significance level of real interest rate reduction increases compared to the baseline regression. Guarantees on bank liabilities were used in all but one crisis after 2007. They were almost always already in place when bank recapitalizations were done. The negative interaction coefficient suggests that guarantees have a more positive (although still insignificant) effect in the first phase of the crisis

Table 6: Estimations with interaction terms between bank recapitalizations and other policies on the sample of 2007 to 2013 crises.

	Recent crises 2008-2013	Recent crises 2008-2013	Recent crises 2008-2013	Recent crises 2008-2013	Recent crises 2008-2013	Recent crises 2008-2013
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Bank recapitalizations	1.5126**	3.2619***	1.8554**	1.4450**	3.0555***	4.3104***
	(2.01)	(2.68)	(2.10)	(2.03)	(2.67)	(2.58)
Guarantees on bank liabilities	0.2769	2.9221	0.0377	0.2640	0.3160	2.1610
	(0.22)	(1.48)	(0.03)	(0.20)	(0.24)	(0.94)
Guarantees * bank recap.		-1.7396*				-1.2486
		(-1.95)				(-1.22)
Liquidity support	-3.6067	-9.0823*	-2.0505	-4.3946	-2.9516	-3.5243
	(-0.80)	(-1.67)	(-0.43)	(-0.96)	(-0.73)	(-0.59)
Liquidity support * bank recap.			-1.0599			-0.6577
			(-0.90)			(-0.60)
Real interest rate reduction	0.2528*	0.4326**	0.2635**	0.4325**	0.4121**	0.6761***
	(1.89)	(2.44)	(2.07)	(2.36)	(2.54)	(2.68)
Real int. rate reduction * bank recap.				-0.0943		-0.0792
				(-1.48)		(-1.12)
Fiscal deficit, cyclically adj.	0.2077	0.1490	0.2368	0.2528	0.3454	0.2840
	(0.97)	(0.60)	(1.06)	(1.11)	(1.46)	(1.00)
Fiscal deficit, cycl. adj. * bank recap.					-0.1455**	-0.1066
					(-2.04)	(-1.07)
Average of bank recapitalizations	-3.2815**	-3.4216**	-4.0347**	-3.3727**	-4.1363***	-4.9512**
	(-1.97)	(-2.12)	(-2.06)	(-2.18)	(-2.63)	(-2.35)
Average of guarantees on bank liab.	-2.3825	-3.9103	-2.4671	-1.6997	-1.8643	-3.0673
	(-1.19)	(-1.58)	(-1.21)	(-0.79)	(-0.85)	(-1.08)
Average liquidity support	2.3497	4.2471	3.1108	2.9685	-3.0218	-0.5763
	(0.42)	(0.71)	(0.56)	(0.53)	(-0.46)	(-0.08)
Average real interest rate reduction	-0.7642***	-0.7404***	-0.8076***	-0.7302***	-0.8662***	-0.8682***
	(-2.90)	(-2.68)	(-2.93)	(-2.80)	(-3.09)	(-2.67)
Average cyclically adj. fisc. def.	-0.2598	-0.2403	-0.2686	-0.3118	-0.3919	-0.3261
	(-0.97)	(-0.76)	(-1.01)	(-1.10)	(-1.33)	(-0.96)
Duration	1.5191	0.9055	1.9354	1.2068	0.7594	0.0505
	(0.79)	(0.52)	(1.13)	(0.70)	(0.52)	(0.03)
Duration^2	-0.0479	-0.0258	-0.1686	-0.0140	0.0921	0.1435
	(-0.14)	(-0.08)	(-0.57)	(-0.05)	(0.35)	(0.54)
Duration^3	-0.0044	-0.0010	0.0058	-0.0045	-0.0119	-0.0102
	(-0.22)	(-0.06)	(0.35)	(-0.25)	(-0.84)	(-0.66)
Constant	-5.1440	-4.2767	-5.5431*	-4.7498	-4.1665	-3.4003
	(-1.58)	(-1.46)	(-1.77)	(-1.64)	(-1.64)	(-1.48)
Observations	170	170	170	170	170	170
Crises	25	25	25	25	25	25
Log likelihood	-35.8520	-33.6307	-35.5098	-34.6523	-33.6776	-31.9634

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

before bank recapitalizations are done but that their effect goes down once recapitalizations are implemented. The negative interaction term with fiscal policy is consistent with the predictions of Van der Kwaak and Van Wijnbergen (2014), who argue that fiscal stimuli in a weak bank capitalization environment are less effective than the same stimuli would have been if banks would have been better capitalized. Since bank recapitalizations are more likely when banks are more undercapitalized, the negative coefficient of the interaction term suggests that fiscal policy is less effective in a weak banks environment, in line with their theoretical results.

3.7 Robustness checks

In this section we perform several additional regressions to check the robustness of our results. Firstly, we include the squared term of bank recapitalizations into the regression specification to check whether each additional amount of recapitalizations is equally beneficial. We find an insignificant positive effect of the squared term on the sample of past crises and a negative effect on the sample of recent crisis. The significance of this effect is, however, driven by one single crisis, Cyprus. The crisis in Cyprus is special in two respects. The recession was still ongoing at the time of our data collection (2013 Q3) and the amount of recapitalizations (17.86% of total banking assets) is an outlier in the 2007-2013 sample. Similarly as Cyprus also the second Greek recession, which started in 2010 Q1 was not yet finished by 2013 Q3. Table 7 reports four regressions with which we investigate the negative effect of squared recapitalization. In column (1) Cyprus as well as all other crises in 2007 to 2013 period are included. The estimated effect of the squared term is negative and highly significant. In column (2) Cyprus is excluded. The effect of squared recapitalizations becomes insignificant. In column (3) also the second Greek recession is included, which does not make any difference compared to column (2). In column (4) we use forecast data for the second Greek recession (and do not include Cyprus). The forecasts from the World Economic Outlook database (IMF 2013a) predict that Greece will recover in 2014 Q1. In addition to that we assume that the values of policy variables will be the same in 2013 Q4 and 2014 Q1 as in 2013 Q3.[18] The estimation results in columns (2), (3) and (4) are very similar; the squared term of bank recapitalizations is always insignificant. Based on this results we conclude that the negative effect of squared recapitalizations is due to Cyprus. A possible interpretation for the negative effect could be that bank recapitalizations that are very large are large not because the government wanted to bring banks to a higher capitalization level than when recapitalizations are intermediate but because the recapitalizations were delayed for

[18] Our data about policy variables runs until 2013 Q2 but because the values of policy variables are lagged in regression we in fact can use actual data until 2013 Q3 and only need to use assumptions for two quarters.

Table 7: Robustness checks to investigate what drives the negative effect of squared bank recapitalizations on the sample of 2007 to 2013 crises.

Recession indicator	Recent crises 2008-2013 Cyprus included (1)	Recent crises 2008-2013 Cyprus excluded (2)	Recent crises 2008-2013 Excl. Cyprus and Greece II (3)	Recent crises 2008-2013 Excl. Cyprus, forecasts for Greece II (4)
Bank recapitalizations	2.7863***	2.3598**	2.3303**	2.2671**
	(2.87)	(2.15)	(2.12)	(2.12)
Bank recapitalizations^2	-0.1308***	-0.0194	-0.0175	-0.0700
	(-2.67)	(-0.17)	(-0.15)	(-0.69)
Guarantees on bank liabilities	0.7316	1.0895	1.1171	0.5362
	(0.60)	(0.86)	(0.85)	(0.45)
Liquidity support	-6.3882	-5.1881	-5.0584	-6.7820
	(-1.39)	(-1.03)	(-0.99)	(-1.49)
Real interest rate reduction	0.3910***	0.3954**	0.3936**	0.3566**
	(2.80)	(2.53)	(2.51)	(2.55)
Fiscal deficit, cyclically adj.	0.2030	0.1583	0.1527	0.2223
	(0.93)	(0.71)	(0.69)	(1.04)
Average of bank recapitalizations	-2.5039	-2.0080	-1.9551	-1.8155
	(-1.27)	(-0.93)	(-0.91)	(-0.89)
Average of bank recapitalizations^2	-0.0099	-0.2372	-0.2408	-0.1065
	(-0.07)	(-0.87)	(-0.89)	(-0.46)
Average of guarantees on bank liab.	-1.1421	-2.0740	-2.1035	-1.1290
	(-0.58)	(-0.96)	(-0.94)	(-0.57)
Average liquidity support	-6.3063	-3.7751	-3.7686	-4.8961
	(-0.97)	(-0.56)	(-0.56)	(-0.72)
Average real interest rate reduction	-0.8028***	-0.8345***	-0.8305***	-0.7864***
	(-3.11)	(-3.13)	(-3.10)	(-3.05)
Average cyclically adj. fisc. def.	-0.4198	-0.3070	-0.2993	-0.4262
	(-1.42)	(-1.00)	(-0.97)	(-1.46)
Duration	1.8593	0.7180	0.7081	2.9799**
	(1.08)	(0.39)	(0.38)	(2.16)
Duration^2	-0.1533	0.1005	0.1023	-0.3339*
	(-0.53)	(0.28)	(0.29)	(-1.73)
Duration^3	0.0042	-0.0128	-0.0129	0.0125*
	(0.28)	(-0.59)	(-0.59)	(1.68)
Constant	-5.3914*	-4.2224	-4.2288	-7.3350**
	(-1.70)	(-1.48)	(-1.48)	(-2.37)
Observations	178	170	156	173
Crises	26	25	24	25
Log likelihood	-34.0987	-33.2302	-33.2013	-34.4881

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

too long. The zombie banks are already deeply insolvent when they are recapitalized. In such circumstances it can be that each additional unit of recapitalization is not as effective as when the scale of problems in the banking sector is smaller. But because this result only depends on one crisis we do not include Cyprus and the squared recapitalizations in the main results in the previous section.

To check whether our results are robust with respect to the definition of recession duration we reestimate the results using either a laxer or a stricter rule to determine which quarters constitute a recession, than in the main results. Under the lax definition we do not require a recession to include two consecutive negative growth quarters; a sequence of a negative, a positive and a negative quarter would now also be considered a recession.[19] In addition to this change we include also recessions that started more than 2 quarters before the start of the banking crises. As these recessions were not related to a banking crisis when they started we only count 4 quarters before the start of the banking crisis and the quarters after the start of the banking crisis as their recession duration. This adds 2 more recessions to the sample.[20] Under the strict definition we only count consecutive negative quarters as recession and do not include recessions that started more than 2 quarter before the banking crisis. Compared to the main definition some recessions are shorter under this definition. They either start later or end sooner. Table 8 provides the estimation results with both recession definitions. The estimates in columns (1) and (4) on the full sample can be compared with column (1) of Table 3, columns (2) and (4) on the sample of past crises with column (2) of Table 3, and columns (3) and (6) on the sample of recent crises with column (4) in Table 3. The estimation results under both alternative definitions are very similar to the main results. The effect of bank recapitalizations and reduction in real interest rate are positive and significant. The estimated effect of liquidity support is positive under the lax definition of recession for the sample of past crises while it was insignificant in the main results and the negative effect of guarantees becomes significant under the strict recession definition on the past crises sample. Otherwise there are no important differences.

In the final robustness check we run the regression using different distribution functions for the duration model. Instead of complementary log-log random effects estimation we use either logit random effect estimation or linear probability model with random effects. Table 9 reports the results. The estimates obtained with logit are very similar to our main results in Table

[19] Under this definition Bolivia had a recession, while it did not have one under the main definition.

[20] Under this definition the recession in Bulgaria is assumed to start in 1995 Q1, and in Uruguay in 2002 Q1. Two other crises with long recessions before the start of the banking crisis, Argentina 1989 and Finland 1991 cannot be included as they have missing data for one of the policies.

3. In the linear probability model the predicted probabilities can lie outside of the [0,1] range but even then the effect of bank recapitalizations remains.

Table 8: Robustness checks with lax and strict definitions of recession duration.

	Lax recession definition			Strict recession definition		
Recession indicator	Full sample 1980-2013 (1)	Past crises 1980-2007 (2)	Recent crises 2008-2013 (3)	Full sample 1980-2013 (4)	Past crises 1980-2007 (5)	Recent crises 2008-2013 (6)
Bank recapitalizations	0.4981***	0.5758**	1.5126**	1.4929***	10.4952***	1.5118*
	(3.01)	(2.19)	(2.01)	(3.41)	(2.83)	(1.79)
Guarantees on bank liabilities	0.2147	-0.7833	0.2769	0.0642	-9.5049**	1.1483
	(0.37)	(-0.55)	(0.22)	(0.10)	(-2.05)	(0.98)
Liquidity support	2.2820	4.1813**	-3.6067	1.3861	3.9983	-1.7372
	(1.54)	(2.09)	(-0.80)	(0.82)	(1.36)	(-0.36)
Growth of reserve money	-0.7008	-1.0296		-0.9572	-0.8084	
	(-1.44)	(-1.59)		(-1.33)	(-0.90)	
Real interest rate reduction			0.2528*			0.3013*
			(1.89)			(1.83)
Fiscal deficit, cyclically adj.			0.2077			0.1400
			(0.97)			(0.64)
Average of bank recapitalizations	-0.9101***	-0.9077**	-3.2815**	-2.4421***	-17.4654***	-1.5597
	(-2.79)	(-2.05)	(-1.97)	(-3.33)	(-2.83)	(-1.12)
Average of guarantees on bank liab.	-0.2221	2.0478	-2.3825	0.0612	13.2054**	-1.4321
	(-0.24)	(1.09)	(-1.19)	(0.06)	(2.15)	(-0.67)
Average liquidity support	-3.4466	-2.9527	2.3497	-1.5375	-3.6407	-1.0577
	(-1.50)	(-1.02)	(0.42)	(-0.66)	(-1.05)	(-0.16)
Average reserve money growth	0.3092	0.1960		0.1336	-0.0348	
	(0.58)	(0.29)		(0.26)	(-0.06)	
Average real interest rate reduction			-0.7642***			-0.5048
			(-2.90)			(-1.60)
Average cyclically adj. fisc. def.			-0.2598			-0.3113
			(-0.97)			(-1.08)
Duration	2.9867***	4.1362***	1.5191	10.6175***	14.7311***	12.6821**
	(3.37)	(2.91)	(0.79)	(3.65)	(2.73)	(2.02)
Duration^2	-0.4211***	-0.6572***	-0.0479	-2.1788***	-3.0337***	-2.3633*
	(-2.88)	(-2.65)	(-0.14)	(-3.50)	(-2.59)	(-1.86)
Duration^3	0.0174**	0.0311**	-0.0044	0.1405***	0.1954**	0.1453*
	(2.46)	(2.47)	(-0.22)	(3.35)	(2.48)	(1.78)
Constant	-7.1655***	-9.1529***	-5.1440	-16.9647***	-23.0266***	-22.2398**
	(-4.38)	(-3.66)	(-1.58)	(-3.93)	(-2.91)	(-2.18)
Observations	343	173	170	270	127	143
Crises	54	29	25	51	26	25
Log likelihood	-102.26	-51.57	-35.85	-72.95	-26.41	-28.90

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. The specifications are estimated using complementary log-log random effects procedure. In parentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 9: Robustness checks with different estimation procedures.

	Logit			Linear probability model		
	Full sample 1980-2013	Past crises 1980-2007	Recent crises 2008-2013	Full sample 1980-2013	Past crises 1980-2007	Recent crises 2008-2013
Recession indicator	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Bank recapitalizations	0.9217***	1.9362**	1.7692**	0.0213**	0.0205*	0.0080
	(3.30)	(2.50)	(1.98)	(2.36)	(1.94)	(0.37)
Guarantees on bank liabilities	0.1109	-4.3222	0.1584	0.0550	0.0106	0.0333
	(0.15)	(-1.60)	(0.11)	(0.87)	(0.08)	(0.40)
Liquidity support	3.5145*	5.4953	-4.2407	0.0838	0.2241	-0.4243
	(1.70)	(1.42)	(-0.72)	(0.43)	(0.81)	(-1.44)
Growth of reserve money	-1.0666	-1.6619		-0.0666	-0.0538	
	(-1.61)	(-1.44)		(-1.26)	(-0.84)	
Real interest rate reduction			0.2987*			0.0177
			(1.84)			(1.31)
Fiscal deficit, cyclically adj.			0.2570			0.0213
			(0.96)			(1.53)
Average of bank recapitalizations	-1.6008***	-3.1527**	-3.8238*	-0.0294**	-0.0188	-0.0273
	(-3.25)	(-2.44)	(-1.94)	(-2.36)	(-1.25)	(-0.82)
Average of guarantees on bank liab.	-0.3524	6.4750*	-2.6210	-0.1028	0.0676	-0.1448
	(-0.31)	(1.91)	(-1.16)	(-1.21)	(0.43)	(-0.97)
Average liquidity support	-4.1150	-3.1733	2.6633	-0.3186	-0.1544	-0.0247
	(-1.47)	(-0.78)	(0.34)	(-1.45)	(-0.45)	(-0.07)
Average reserve money growth	0.3374	0.2478		0.0660	0.0518	
	(0.52)	(0.33)		(0.78)	(0.54)	
Average real interest rate reduction			-0.8285***			-0.0352
			(-2.59)			(-1.41)
Average cyclically adj. fisc. def.			-0.3184			-0.0292*
			(-0.99)			(-1.80)
Duration	3.1358***	11.0233**	1.8056	0.0191	0.0018	0.0285
	(2.60)	(2.25)	(0.80)	(0.47)	(0.02)	(0.52)
Duration^2	-0.3940*	-2.2231**	-0.0679	0.0143	0.0251	0.0128
	(-1.90)	(-2.07)	(-0.16)	(1.54)	(0.81)	(1.09)
Duration^3	0.0129	0.1439**	-0.0043	-0.0012**	-0.0020	-0.0009
	(1.20)	(1.96)	(-0.18)	(-2.17)	(-0.72)	(-1.33)
Constant	-7.5508***	18.4472**	-5.4396	0.0707	-0.0172	0.1237
	(-3.52)	(-2.57)	(-1.44)	(1.28)	(-0.20)	(1.36)
Observations	317	147	170	317	147	170
Crises	51	26	25	51	26	25
Log likelihood	-88.6471	-37.0105	-36.6919			

RECESSION INDICATOR is the dependent variable having value 1 if a country has just recovered from a recession and 0 if it is in a recession in a particular quarter. A positive regression coefficient means that a higher value of the explanatory variable increases the probability of recovery. BANK RECAPITALIZATIONS are the cumulative amount of recapitalizations since the start of the banking crises, weighted by total banking assets. GUARANTEES ON BANK LIABILITIES are an indicator variable for the presence of guarantees. LIQUIDITY SUPPORT is the ratio of central bank claims on other depository corporations divided by the total deposits at other depository corporations. GROWTH OF RESERVE MONEY and REAL INTEREST RATE REDUCTION are measures of monetary policy. CYCLICALLY ADJUSTED FISCAL DEFICIT is a measure of discretionary fiscal policy. All policy variables except for fiscal deficit are lagged one quarter. Averages of intervention variables are included to allow for correlation between intervention and the time invariant component of unobservable crisis severity. DURATION is the number of quarters a recession has already been ongoing until the period for which the probability of recovery is estimated. In nparentheses are z-values of the tests for significance of coefficients. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

3.8 Conclusions

In this chapter we ask the question: how costly is regulatory forbearance that allows zombie banks to continue to operate? More specifically, how much longer will a recession last if distressed banks are not recapitalized? We analyze recessions after 68 systemic banking crises in the period from 1980 to 2013. Our approach takes into account that intervention in banking crises is endogenous to crisis severity. We estimate a duration model with crisis-specific fixed effects, allowing for the possibility that the average level of intervention over the crisis period is correlated to unobservable crisis severity. We find a positive and highly significant effect of bank recapitalizations on the probability of recovery. We do not find such support for the effectiveness of guarantees on bank liabilities or liquidity support. For the purpose of addressing the undercapitalization problem these policies are inferior to bank recapitalizations.

The theoretical part offers a potential explanation of these results. We model a channel through which intervention measures could affect aggregate output. Undercapitalized banks have incentives to roll over loans to distressed borrowers instead of restructuring or liquidating them. In that way zombie banks form a drag on economic recovery. They continue funding inefficient firms and ration credit to new borrowers with good projects. Bank recapitalizations can mitigate these adverse incentives and hence shorten recessions. Other intervention measures such as guarantees on bank liabilities and liquidity support are not as effective because they do not address the perverse incentives coming from undercapitalization.

We compute expected recession durations at different values of intervention variables while keeping crisis severity constant. The results clearly show that bank recapitalizations substantially reduce expected recession duration. Looking at actual durations, one finds, however, that crises where bank recapitalizations took place have a similar duration as those crises where no recapitalization was done. In both cases the average duration is about 5 quarters. But this is a false comparison. A typical crisis where banks were not recapitalized would have lasted only 3 quarters with recapitalization, while a crisis where banks were recapitalized would have had a recession duration of 11 quarters without recapitalization.

Our findings show that recapitalizing banks is an effective intervention from the ex post perspective. If also the ex ante perspective is considered, a number of interesting questions can be raised. What is the tradeoff between the ex post optimal intervention and banks' ex ante incentives that anticipate such intervention? What role do (ex ante) capital requirements play? We leave this questions for future research.

Chapter 4
Bank Recapitalizations and Lending

4.1 Introduction

Government recapitalizations of distressed banks are highly unpopular with the general public. The main reasons are the fiscal burden they impose on the taxpayers, the moral hazard with respect to future crises and the perception that they create rents for bankers. On the other side of the trade-off, particularly relevant during systemic banking crises when a large part of the banking sector is undercapitalized, are the costs of regulatory forbearance. When distressed banks are not recapitalized, they are likely to lend less or engage in zombie lending, which leads to depressed growth (Caballero, Hoshi, and Kashyap 2008; Peek and Rosengren 2005). The fiscal costs of intervention and the output losses resulting from a weak banking sector raise questions about how effective government equity injections really are. Do they increase bank lending? How do they affect bank funding and loan restructuring? Is the lending induced by recapitalizations directed toward efficient projects? How large recapitalizations should be? Theory suggests banks should be recapitalized when preserving bank-borrower relationships is valuable (Diamond 2001). The level of bank capital is critical both for the bargaining between the bank and investors, and the negotiations of the bank with borrowers (Diamond and Rajan 2000). Undercapitalized banks are subject to the debt overhang problem (Myers 1977). They may forgo profitable new lending as the benefits would mostly accrue to the creditors. An efficient recapitalization program should be designed in way to reduce the debt overhang problem, while limiting the rents it creates for the banks (Philippon and Schnabl 2013). Furthermore, undercapitalized banks may underreport the extent of nonperforming loans to avoid closure or overstate them to receive a larger bailout (Aghion, Bolton, and Fries 1999). The former leads to evergreening of loans to nonviable borrowers. The latter could result in excessive liquidation. An optimal recapitalization problem should take into account both inefficiencies.

The empirical literature has focused on two main questions about recapitalizations, whether recapitalizations increase loan supply and whether they increase or reduce bank risk taking. Li (2013) investigates the effect of equity injections under the Troubled Asset Relief Program (TARP) and finds that they increase loan supply. Conversely, Duchin and Sosyura (2014) who look at mortgage loan applications, find that after receiving TARP funds banks originated riskier loans, but there seems to be no effect on the amount of lending. Giannetti and Simonov (2013) provide insight into both issues by analyzing recapitalizations of Japanese banks. They find that properly recapitalized banks increased lending to creditworthy borrowers, whereas those that received a too small recapitalization, such that they were still in breach of regulatory capital requirements after being recapitalized, only extended more loans to zombie firms. We contribute to this literature by documenting the effect of recapitalizations on multiple aspects of bank behavior, more specifically lending, investing into government securities, adjustment of risk weighted assets, access to different types of funding, loan loss provisioning and recognition of impaired loans.

We analyze recapitalizations of publicly traded European banks in the period from 2000 to 2013. The main identification concern in estimating the effect of intervention is that recapitalized banks are typically experiencing substantial distress before they are intervened. Comparing the distressed recapitalized banks with healthy non-recapitalized ones without properly controlling for the differences between them could lead to biased results. Several papers use political and regulatory connections of banks to instrument the probability of receiving a bailout (Li 2013; Duchin and Sosyura 2014; Berger et al. 2014). We control for bank distress directly by using the market implied capital shortfall as a measure of undercapitalization or distress of banks. This way we can compare banks that are recapitalized with those that are similarly undercapitalized but not (yet) intervened or receive a different recapitalization amount.

We find that a year after being recapitalized, banks increase lending, attract more deposits and make more loan loss provisions. The effects are increasing in the size of recapitalization, relative to total assets of a bank. These positive effects, however, do not apply to banks that receive a small recapitalization relative to their capital shortfall. Following such a recapitalization, banks suffer a drop in deposits and interbank funding. Consequently, they cut back on lending. Similarly, banks with a low Tier 1 ratio after recapitalization, which implies the recapitalization was too small to bring them up to a higher capital ratio, shrink risk weighted assets and increase lending significantly less than banks with a high Tier 1 ratio after recapitalization. Overall, these results suggest that sufficient recapitalizations lead to a substantial increase in lending, whereas banks that get a small recapitalization relative to their

shortfall carry out adjustment through reduction of lending and shrinking of risk weighted assets.

The paper is organized as follows. Section 4.2 reviews the related literature. Section 4.3 presents the empirical methodology. Section 4.4 describes the data. Section 4.5 discusses the results. Robustness checks are in Section 4.6. Section 4.7 concludes.

4.2 Review of related literature

To answer the question whether bank recapitalizations are beneficial, empirical literature has investigated the effects of recapitalizations on bank lending and risk taking. From the effects on loan supply and measures of risk, some inferences can be made about whether recapitalizations lead to efficient allocation of resources. Recent papers studying the effect of government equity injections mostly focus on the Capital Purchase Program (CPP) implemented under the TARP program in the US in the second half of 2008 and 2009. Li (2013) finds that injections of preferred stock with warrants increased loan supply of recapitalized banks. He instruments the indicator for participation at CPP with political connectedness of banks. Those better connected, measured by political contributions of local financial industry to congressmen and by whether the bank has representatives in regulatory bodies, are more likely to receive a bailout. With a similar approach, Duchin and Sosyura (2014) analyze loan mortgage applications and find that banks with TARP funds approved more risky loans, i.e. loans with significantly lower loan to income ratios, the key criterion for the risk of mortgages. But they do not find that recapitalized banks increased loan approvals in general. Interestingly, Black and Hazelwood (2012) find that following the TARP injections the average risk of commercial and industrial loans originated by large banks increased, while small banks originated loans with significantly lower risk, compared to banks that did not receive capital support. Berger and Roman (2013) show that banks that received TARP injections gained a competitive advantage in terms of both market share and market power; the effects are particularly strong for banks that repaid the injections early. Conclusions about whether origination of loans with higher risk is valuable from the social perspective cannot be easily drawn. Higher risk of new loans may mean banks are extending loans to small and medium enterprises with good projects instead of buying government securities with low risk weights or that they are taking on excessive risks as a consequence of moral hazard.

The paper that is able to most directly distinguish between efficient and wasteful lending is Giannetti and Simonov (2013). They analyze equity injections into Japanese banks between 1998 and 2005. In the first round of recapitalizations all banks received similar injections to

avoid signaling, which produced variation across banks; some were still in breach of capital requirements after the intervention. The banks that were sufficiently recapitalized increased lending to creditworthy borrowers with whom they had closer relationships and reduced the exposure to insolvent borrowers. Those that were still undercapitalized after the injection, however, reacted to recapitalizations in the opposite way: they did not increase lending in general but only extended more loans to zombie firms. This is consistent with our results, which show that bank recapitalizations only increase lending if they are large enough, relative to the capital shortfall before recapitalization. Unlike Giannetti and Simonov (2013), we cannot provide direct evidence that the increase in lending resulting from recapitalizations is aimed at productive projects. However, considering also the results that banks receiving larger recapitalizations improve their access to market funding and clean up their balance sheets, our findings suggest that new lending is not directed at value-destroying projects.

Another way to answer the question, whether recapitalizations are beneficial is to look at the outcomes in the real sector. Chodorow-Reich (2014) documents that in crisis times firms are mostly not able to switch to another bank if their main bank suffers a shock to its capital and as a result reduces lending. Consequently, firms borrowing from affected banks are forced to reduce employment. Recapitalizing distressed banks could mitigate these negative effects. Berger and Roman (2015) provide some evidence for this by performing a differences-in-differences analysis of the effects of TARP at state level. They find that TARP injections increased job creation and reduced business as well as personal bankruptcies. Furthermore, Homar and Van Wijnbergen (2014) analyze recessions related to systemic banking crises and find that recapitalizing banks substantially reduces recession duration. To sum up, the existing literature shows that in general the effects of recapitalizations on lending as well as macroeconomic outcomes appear to be positive but that there could also be cases where recapitalization funds are channeled into zombie lending or other inefficient risky investments.

4.3 Empirical methodology

We analyze the effects of bank recapitalizations on lending, bank funding and asset quality. Recapitalizations, typically in the form of an equity injection by the government or a conversion of claims to private creditors, are done when banks are distressed, which poses an identification problem as distressed banks are different from those that are not distressed. Ideally, one would compare a group of recapitalized banks with a group of banks that are similarly distressed but for some random reason not (yet) recapitalized. Estimating the effect of recapitalizations, while

controlling for the level of distress, is key to our analysis. In this section, we explain the identification concerns and how our empirical setup addresses them.

Recapitalized banks may differ from those that are not recapitalized in a number of ways. Firstly, banks that are at some point recapitalized may be intrinsically different from those that are never recapitalized. They may be pursuing riskier strategies, leading to more aggressive growth in normal times, or their monitoring ability may be lower, which may show up in a higher ratio of nonperforming loans in general. We control for this type of time invariant differences by using bank fixed effects.

Secondly, undercapitalized banks are likely to behave differently than adequately capitalized ones even after controlling for the standard observable bank characteristics. Therefore it is critical to control for the initial level of undercapitalization of intervened banks. We do this by including the level of market implied capital shortfall at the end of the period before a bank is recapitalized, into the regression specifications. This way, recapitalized banks can be compared with banks that are similarly undercapitalized or distressed but are not (yet) intervened or received a recapitalization of different size. Market implied capital shortfall measures how much equity capital a bank would be missing compared to a benchmark market leverage ratio if the economy was hit by a severe shock.[21] Capital shortfall is computed from SRISK, a systemic risk measure proposed by Acharya, Engle, and Richardson (2012). Using a market measure has the advantage that it incorporates bank distress promptly and also includes information about losses that are not yet recognized on the balance but are already incorporated into the market valuation. Thus it is likely to be a better measure of undercapitalization than regulatory capital ratios.[22]

Thirdly, bank recapitalizations are usually done in times when financial sector in general is experiencing distress and the economy is performing worse than in normal times. In such periods loan growth is likely to be lower and asset quality worse. To account for this, we include country specific time fixed effects. They capture distress and also any policy intervention that is not bank specific such as monetary policy, guarantees on bank liabilities etc. To the extent that loan demand varies at country level, country-year fixed effects also capture variation in country specific loan demand.

Finally, an identification concern could be that the regulator always intervenes optimally. If the regulator had perfect information and would be following an optimal intervention policy, the variation in observed intervention could not be exploited. The recapitalizations would be

[21] More details about the capital shortfall measure are provided in the Data section.

[22] We perform robustness checks with regulatory ratios.

strictly based on the condition of the distressed banks, so the amount of recapitalization would be informative about the distress/undercapitalization not captured by market implied shortfall and other controls but may appear to have little effect on the outcome variables. Because our dataset includes multiple countries with large variation in recapitalization amounts and timing of recapitalizations, it is highly unlikely that recapitalization amounts would always be optimal. In some countries recapitalizations were done early in the crisis; in others undercapitalized banks were around for long time. Also anecdotal evidence suggests that the approaches of regulators differ across countries. This variation insures that there is randomness in recapitalization amounts and timing, which enables us to estimate the effect of recapitalizations, controlling for the factors discussed above.

The estimation equation is the following:

$$\Delta Y_{i,t} = \beta_1 \frac{RECAP_{i,t}}{TA_{i,t-2}} + \beta_2 \frac{RECAP_{i,t-1}}{TA_{i,t-2}} + \beta_3 \frac{STFALL_{i,t-2}}{MVTA_{i,t-2}} + \beta_4 ROA_{i,t-2} \beta_5 SIZE_{i,t-2} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

Dependent variable $\Delta Y_{i,t}$ is a change scaled by total assets if $Y_{i,t}$ is a balance sheet item and a change in ratio when $Y_{i,t}$ is itself a ratio; e.g. the change in loans and the change in risk weighted assets ratio are defined as:

$$\Delta LOAN_{i,t} = \frac{LOAN_{i,t} - LOAN_{i,t-1}}{TA_{i,t-1}} \quad (2)$$

$$\Delta RWA / TA_{i,t} = \frac{RWA_{i,t}}{TA_{i,t}} - \frac{RWA_{i,t-1}}{TA_{i,t-1}} \quad (3)$$

In regressions about asset quality the dependent variables are simply the ratios $Y_{i,t}$ (e.g. the ratio of loan loss provisions to total gross loans) and not changes in ratios. Variables $RECAP_{i,t}$ and $RECAP_{i,t-1}$ are recapitalization amounts received by bank i in year t and $t-1$, respectively. There may be multiple recapitalizations in one year if equity injections were done in multiple tranches. Both the sum of recapitalizations in year t and the sum in year $t-1$ are scaled by total assets at the end of year $t-2$, which is just before the first recapitalization may take place. We include both recapitalization variables into the regression specification to differentiate between the immediate effect of recapitalizations and the effect in about a year. More precisely, $RECAP_{i,t}$ is the amount of recapitalization a bank received during the year over which the change in the outcome variable $\Delta Y_{i,t}$ is computed; $RECAP_{i,t-1}$ is the recapitalization amount in the preceding year. Market implied capital shortfall $STFALL_{i,t-2}$ divided by the market value of total assets

controls for the undercapitalization or distress just before the bank may be intervened.[23] The control for bank size is the logarithm of total assets, $SIZE_{i,t-2} = \ln\left(TA_{i,t-2}\right)$. Bank fixed effects are denoted by γ_i ; δ_t are either year fixed effects or country specific year fixed effects. We estimate the regressions using a within estimator that provides Driscoll-Kraay (1998) standard errors. The estimates are identical to the OLS within estimator, while the standard errors are robust against heteroscedasticity, autocorrelation and cross-sectional dependence of residuals. We use the procedure by Hoechle (2007), who modified Driscoll-Kraay (1998) estimator to make it suitable for unbalanced panels.

4.4 Data

We start by collecting data on bank recapitalizations in European countries that experienced significant bank distress during the recent global financial crisis.[24] To be able to control for the level of distress of recapitalized banks, we match the recapitalized banks with market implied capital shortfall data provided by Acharya, Engle, and Richardson (2012)[25]; the latter limits the sample to publicly traded banks. With our empirical setup, we can investigate the effect of recapitalizations only on banks that are publicly traded at the time just before they are intervened. It is, however, not necessary for the banks to be publicly traded after the intervention. In addition to the recapitalized banks, our sample includes banks that were not recapitalized and were publicly traded sometime during the period of 2000 to 2013 in countries where at least one publicly traded bank was recapitalized during that period. Finally, we combine the data on recapitalizations and capital shortfalls with bank balance sheet and other data from Bureau van Dijk BankScope database. We begin this section by describing the data on bank recapitalizations. Subsequently, we provide variable definitions and discuss some descriptive statistics.

The primary source of information on bank recapitalizations are decisions of the European Commission about state aid cases. In addition, we use IMF staff reports, webpages of central banks, treasuries and restructuring agencies, and annual reports of banks. There are multiple measures that can be considered a bank recapitalization. When we talk about bank recapitalizations, we have in mind government injections of equity into distressed banks and

[23] Market value of total assets $MVTA$ is computed as the sum of market value of equity and book value of total liabilities.

[24] In addition to most of the EU member states these include Iceland, Russia, Switzerland and Ukraine.

[25] The data are available on their website http://vlab.stern.nyu.edu at monthly frequency from 2000 onwards.

forced conversions of bank liabilities into equity in the process of bank restructuring. The precise rules are as follows.

Measures counted as recapitalization:

- Injections of common equity, preferred stock, conditionally convertible bonds or any Tier 1 qualifying instrument by a state, a bank restructuring agency or other government agency.
- Conversions of subordinated debt or other bank liabilities into equity (often called liability management exercises). A necessary condition for such a measure to be counted as a recapitalization is that the creditors get a Tier 1 qualifying instrument in exchange for their former claim. The amount counted as recapitalization is the notional value of the new claim, not the amount of the original claim.[26]

Measures not counted as recapitalization:

- Any securities purchased by private investors even if the state has participated in the same issue. Only the amount purchased by the state is counted. A broader definition of bank recapitalizations could include issues of equity to private investors that are a result of regulatory intervention. Apart from a few instances where private investors purchased a small number of shares around the time of a government equity injection, the data sources from which we obtain data on recapitalizations do not cover equity issues to private investors. Because we do not have sufficient data on equity injections by private investors, we focus only on those by governments or public institutions.
- Injections of subordinated debt or any Tier 2 qualifying instrument.
- Write-offs of bank liabilities where creditors do not get any security in exchange for giving up their claim. These write-offs are sometimes referred to as the contribution of bondholders to recapitalization. One may argue that such a write-off is similar to a conversion of liabilities into equity, which is then used to absorb the losses. The important difference is that in case of a write-off the value is written-off immediately and the creditors cannot participate in the upside, while with a conversion to equity losses are offset more gradually and there is a possibility of an upside.
- Compensation for the funding gap in purchase and assumption deals. When the value of liabilities of the acquired bank exceeds its value of assets, the state or a government agency typically compensates the acquirer for the funding gap to facilitate the deal. We do not count this transfer as a recapitalization since it only benefits the creditors of the

[26] If the value of the new claim is not available, we use the amount of liabilities converted.

bank whose claims would otherwise have to be written off before the acquirer would be willing to purchase the distressed bank.

- Value of guarantees on bank assets, swaps or other instruments provided by governments, which insure a bank against losses from specific assets. This protection has a capital relief effect (it reduces the required regulatory capital, which a bank needs to hold for those assets) and may increase the market value of bank equity. The value of such measures is difficult to estimate.[27] Accounting for all measures that may increase bank capital through providing implicit or explicit guarantees would not be feasible. Therefore we focus on intervention measures where the party that recapitalizes a bank gets equity or equity-like securities in exchange for its contribution.

Our original dataset of recapitalizations includes 90 recapitalized banks, both private and publicly traded, from 22 European countries. Appendix on page 133 provides details about it.[28] For each recapitalization it reports the date, amount and a short description of the measure. Of these banks we can analyze 41 that were publicly traded at the time when they received their first recapitalization. Because of this limitation the number of countries drops to 15 as in some countries none of the recapitalized banks were publicly traded at the time of intervention.[29]

Market values of bank equity and market implied capital shortfalls are from V-Lab (Acharya, Engle, and Richardson 2012). The measure of shortfall is SRISK, which is defined as the gap between the required capital and the actual market value of bank equity in case of a severe shock to the economy that would cause a 40% drop in a broad stock market index over a period of six months. Capital requirement used to compute the market implied shortfall is in the form of market leverage ratio;[30] the benchmark value, which banks need to satisfy also in case of a shock, is 5.5%.[31] SRISK can take positive as well as negative values. A positive value indicates a shortfall of capital. A negative value, on the other hand, implies that the bank has capital in excess of what is needed to not fall below the benchmark in the stress scenario. We define shortfall as SRISK if SRISK is positive and zero otherwise. Then we scale it by the market value of total assets.

---

[27] For an example see Van Wijnbergen and Treur's (2011) valuation of a swap agreement between ING and the Dutch Government. A major issue is how to take into account the prior expectation of state aid built into the stock price before the support is granted.

[28] Because the dataset reported in the Appendix is used also for the analysis in Chapter 3 it includes recapitalizations of non-European banks that are not part of the sample in relevant for this chapter.

[29] Banks from Denmark, Hungary, Iceland, Luxembourg, Russia, Sweden and Ukraine are included in our initial dataset of recapitalizations but drop out once we require the analyzed banks to be publicly traded.

[30] Market value of bank equity over the sum of market value of equity and book value of total liabilities

[31] This is the default value that Acharya, Engle, and Richardson (2012) use for European banks.

Data on bank loans, funding sources, asset quality and other variables needed for regression analysis come from BankScope financials database. Definitions of these variables are in Table 14 in the Appendix on page 79. Table 1 provides descriptive statistics for variables used in the analysis. Columns (7) and (8) compare banks that were recapitalized with banks that were never recapitalized. For the recapitalized banks, the means are computed over the period before recapitalization. For the non-recapitalized banks the means refer to the period until 2009 so that the period is roughly comparable to the one of the recapitalized banks; the median year in which recapitalizations were done is 2009. The recapitalized and non-recapitalized banks are

Table 1: Descriptive statistics.

Variable	N (1)	Mean (2)	St. dev. (3)	Min (4)	Median (5)	Max (6)	Mean, recap. banks before interv. (7)	Mean, nonrecap. banks before 2010 (8)	Diff. recap. vs. nonrecap. (9)
Total assets	1,319	231,967	455,742	2.2369	38,596	3,220,271	218,669	162,298	56,370**
Book equity	1,319	10,934	22,516	-2,324	1,987	227,429	9,018	8,161	857
Market capitalization	1,006	13,037	22,646	27.7399	2,818	159,468	15,743	13,277	2,466
Market value of TA	1,006	280,342	497,957	904	51,772	3,139,847	269,814	220,395	49,419
SRISK	1,006	8,761	27,054	-96,932	356	192,093	5,275	2,265	3,010*
Capital shortfall	1,006	0.0233	0.0260	0.0000	0.0119	0.0798	0.0198	0.0124	0.0073***
Recap/ TA	41	0.0380	0.0656	0.0015	0.0133	0.2675			
Recap/ shortfall	40	0.6160	1.0042	0.0200	0.2545	4.4792			
Recap year	41	2010	1.7	2008	2009	2013			
Market leverage ratio	1,006	0.0827	0.0881	0.0045	0.0614	0.7140	0.0795	0.0998	-0.0203***
Book leverage ratio	1,319	0.0685	0.0496	0.0093	0.0621	0.7555	0.0576	0.0725	-0.0150***
Regulatory capital ratio	1,040	0.1273	0.0358	0.0733	0.1180	0.2890	0.1108	0.1222	-0.0114***
Tier 1 ratio	1,050	0.1026	0.0414	0.0530	0.0906	0.2930	0.0852	0.0952	-0.0100***
Gross loans, growth	1,216	0.0832	0.1544	-0.3417	0.0585	0.6955	0.1456	0.0980	0.0475***
Gross loans/ TA	1,319	0.6073	0.1916	0.1042	0.6367	1.0840	0.5706	0.6288	-0.0582***
Loans excl. interbank/ TA	1,244	0.5077	0.2073	0.0018	0.5343	0.9071	0.4784	0.5168	-0.0384***
Inter bank lend./ TA	1,295	0.1061	0.0820	0.0022	0.0876	0.6329	0.1038	0.1186	-0.0148**
Govt. securities/ TA	872	0.0719	0.0695	0.0000	0.0587	0.6727	0.0833	0.0552	0.0282***
Risk weighted assets/ TA	711	0.5334	0.1917	0.0000	0.5485	1.0439	0.5658	0.5755	-0.0097
Customer deposits/ TA	1,292	0.4597	0.1790	0.0000	0.4655	0.9165	0.4844	0.4507	0.0337***
Inter bank borrow./ TA	1,293	0.1531	0.1252	0.0000	0.1242	0.7447	0.1341	0.1603	-0.0262***
Senior LT debt/ TA	1,171	0.1448	0.1178	0.0000	0.1221	0.6510	0.1319	0.1578	-0.0258***
Subordinated debt/ TA	1,178	0.0165	0.0123	0.0000	0.0159	0.0930	0.0186	0.0160	0.0026***
Impaired loans/ Gr. loans	990	0.0546	0.0652	0.0011	0.0331	0.3572	0.0386	0.0401	-0.0015
Loan loss prov./ Gr. loans	1,279	0.0103	0.0255	-0.0010	0.0053	0.2213	0.0066	0.0096	-0.0030*
Loan loss reserv./ Gr. loans	1,183	0.0311	0.0267	0.0002	0.0238	0.1512	0.0310	0.0257	0.0054***
Loan charge-offs/ Gr.loans	450	0.0061	0.0074	0.0000	0.0041	0.0481	0.0047	0.0059	-0.0012
Loan recoveries/ Gr. loans	353	0.0038	0.0058	0.0000	0.0009	0.0284	0.0026	0.0036	-0.0010
ROA	1,318	0.5214	1.3699	-4.8600	0.5200	8.6200	0.5672	0.7403	-0.1732**
ROE	1,317	5.6387	18.3913	-105	7.9600	37.2100	9.4663	8.4221	1.0442

Columns (1) – (6) provide descriptive statistics for the full sample. Column (7) reports the mean values of recapitalized banks over the period before they were recapitalized. Column (8) reports the mean values of banks that were not recapitalized; the means are computed over the period 2000-2009 so that the time period approximately matches the one of the recapitalized banks (the median recapitalization year is 2009). Column (9) reports the difference between columns (7) and (8). RECAP/TA and RECAP YEAR refer only to observations of recapitalized banks in the year of recapitalizations. Total assets are denoted as TA and market value of total assets as MVTA. The denominators in asset quality are gross loans. See Table 14 in the Appendix for variable definitions. Values of variables that are not ratios are reported in million EUR. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

comparable in terms of asset size. The difference in book value of total assets is statistically significant, while the difference in the market value of total assets is not. The banks that were later recapitalized have on average larger capital shortfall and lower market leverage ratio as well as lower regulatory capital ratios. The difference in market leverage ratio appears to be larger than the differences in regulatory ratios. Recapitalized banks have a lower ratio of loans to total assets and a higher proportion of government securities. There is, however, no significant difference in the ratio of risk weighted to total assets between the recapitalized and non-recapitalized banks. Deposits as a source of funding are slightly more important for the recapitalized banks than for those that were not recapitalized; the latter borrow somewhat more on the interbank market and in the form of senior long term debt. In terms of asset quality, recapitalized banks have higher loan loss reserves relative to gross loans ratio but do not differ in the ratio of impaired loans. Profitability of recapitalized banks measured as return on assets is somewhat lower than of those not recapitalized, while there is no significant difference in return on equity.

Table 2 lists all bank recapitalizations and reports the amount of recapitalization relative to total assets, capital shortfall before recapitalization, recapitalization amount relative to capital shortfall and Tier 1 capital ratio after recapitalization. Recapitalization amount relative to capital shortfall varies widely across banks, ranging from 2% of capital shortfall to 447%. This suggests some banks received only a fraction of what they would need to be adequately capitalized according to the measure of market implied capital shortfall, while others have received a multiple of that amount. Also Tier 1 ratio at the end of the year in which a bank is recapitalized, covers a wide range – from 5.3% of risk weighted assets to 19.9%. This variation suggests that the approach how to determine the recapitalization amount differs a lot across countries. In general banks that received small amounts relative to their capital shortfall tended to be the largest banks. Those that had relatively low Tier 1 ratio after the recapitalization were often banks from distressed countries. We discuss the differences between small and large recapitalizations in more detail in the next section where we analyze their effects in a regression framework.

Table 2: Bank recapitalizations

Bank	Country	Year	Total assets [bn]	Recap [bn]	Recap/ TA	Capital shortfall	Recap/ shortfall	Tier 1 ratio
Erste Group Bank AG	AT	2009	201.71	1.22	0.61	6.33	10.01	9.20
Oesterreichische Volksbanken AG	AT	2009	48.12	1.00	1.79	0.00		9.20
Raiffeisen Bank International AG	AT	2009	76.28	1.75	2.05	5.95	42.39	11.00
Dexia SA	BE	2008	651.01	6.37	1.05	8.28	13.82	10.60
KBC Groep NV	BE	2008	355.32	3.50	0.98	6.53	16.34	8.89
KBC Groep NV	BE	2009	324.23	3.50	0.99	6.50	15.62	10.76
Dexia SA	BE	2012	357.21	5.50	1.33	5.26	18.82	19.90
UBS AG-REG	CH	2008	2014.82	6.00	0.26	3.71	6.90	11.00
Bank of Cyprus Plc	CY	2013	30.34	8.30	26.75	6.02	388.76	10.20
Commerzbank AG	DE	2008	625.22	8.20	1.33	7.12	19.29	10.10
Commerzbank AG	DE	2009	844.10	10.00	1.60	6.96	23.87	10.50
CaixaBank	ES	2010	273.02	0.98				8.92
Banco de Sabadell SA	ES	2011	100.44	5.25	5.41	4.33	151.18	10.17
Banco de Valencia SA	ES	2012	21.50	5.50	24.48	7.61	322.58	
BNP Paribas	FR	2008	2075.55	2.55	0.15	8.82	2.00	7.80
Credit Agricole SA	FR	2008	1653.22	3.00	0.21	8.87	2.70	8.60
Societe Generale	FR	2008	1130.00	1.70	0.16	7.98	2.22	8.43
Natixis	FR	2009	449.22	5.00	0.90	6.91	14.36	9.70
National Bank Of Greece	GR	2011	106.87	1.00	0.83	5.97	15.79	5.30
Piraeus Bank SA	GR	2011	49.35	15.18	26.32	6.55	447.92	5.30
Alpha Bank AE	GR	2012	58.25	1.90	3.21	6.43	48.03	
EFG Eurobank Ergasias SA	GR	2012	67.65	3.97	5.17	6.75	72.22	11.60
National Bank Of Greece	GR	2012	104.80	7.43	6.95	6.23	107.05	6.70
Piraeus Bank SA	GR	2012	70.41	4.70	9.52	6.31	136.67	9.30
Allied Irish Banks PLC	IE	2009	174.31	3.50	1.92	7.74	27.18	7.20
Governor & Co of the Bank of Ireland	IE	2009	181.11	3.50	1.80	7.14	26.05	9.80
Allied Irish Banks PLC	IE	2010	145.22	3.70	2.12	6.15	35.21	5.30
Governor & Co of the Bank of Ireland	IE	2011	154.88	5.30	3.16	6.63	46.04	14.40
Irish Life & Permanent Group Hldgs	IE	2011	72.04	2.70	3.57	6.97	49.62	17.90
Banca Monte dei Paschi di Siena SpA	IT	2009	224.82	1.90	0.89	4.72	24.86	7.52
Banca Popolare di Milano Scarl	IT	2009	44.28	0.50	1.11	3.13	38.20	8.62
Banco Popolare SC	IT	2009	135.71	1.45	1.19	5.41	22.43	7.69
Piccolo Credito Valtellinese Scarl	IT	2009	24.90	0.20	0.85	2.17	54.64	6.62
Banca Monte dei Paschi di Siena SpA	IT	2013	199.11	2.00	0.91	5.82	14.75	10.62
ING Groep NV	NL	2008	1331.66	10.00	0.76	8.00	10.29	
SNS REAAL NV	NL	2008	125.36	0.75	0.73	9.64	8.09	
SNS REAAL NV	NL	2013	124.57	2.70	2.02	6.94	30.60	16.60
Banco BPI SA	PT	2012	44.56	1.50	3.49	5.77	58.87	14.90
Banco Comercial Portugues SA	PT	2012	89.74	3.00	3.21	5.95	53.73	11.70
Royal Bank of Scotland Group PLC	UK	2008	2401.65	20.00	1.05	9.64	11.03	10.00
Lloyds Banking Group PLC	UK	2009	1027.26	17.00	3.90	8.25	59.14	9.60
Royal Bank of Scotland Group PLC	UK	2009	1696.49	25.50	1.06	9.52	14.69	14.10

The table lists bank recapitalizations. Total assets and recapitalization amount are reported in billions of national currency. RECAP/TA is recapitalization amount scaled by total assets and reported in percent. Capital shortfall is the market implied capital shortfall before recapitalization. It is reported as a percent of the market value of total assets. Tier 1 capital ratio (in percent) is reported at the end of the year in which a bank was recapitalized.

4.5 Results

This section presents the results of the effect of bank recapitalizations on lending, bank funding and asset quality. Table 3 reports the estimations for total gross loans, loans excluding interbank lending, interbank lending, holdings of government securities, risk weighted assets, risk

weighted assets ratio and total assets. Gross loans are the amount of loans outstanding. Net loans, which are commonly referred to just as loans, are gross loans reduced by loan loss reserves. Loans excluding interbank lending are our proxy for retail and corporate lending. We differentiate between the immediate effect of recapitalizations and the effect in about a year. Coefficient $RECAP_t$ denotes the effect of recapitalizations injected during the year over which the change in outcome variables is computed. Coefficient $RECAP_{t-1}$ refers to the effect in about a year. Almost a half of recapitalizations in our dataset were implemented in the fourth quarter of the calendar year. Hence, we expect to observe the main effect of recapitalizations in the year after the recapitalizations are done. This is indeed the case. Gross loans as well as loans excluding interbank lending and holdings of government securities increase significantly in the year after recapitalizations. In the year when recapitalizations are done there is no significant effect on these variables yet. In contrast, there seems to be no significant effect on interbank loans. Higher lending shows up in a significant increase in both risk weighted and total assets. The increase in total assets is relatively larger, leading to a decrease in the ratio of risk weighted to total assets.

Table 3: Effect of recapitalization on lending and asset growth.

	Gross loans, change	**Loans excl. interbank, change**	**Interbank lending, change**	**Govt. securities, change**	**Risk weighted assets, change**	**Risk w. assets/TA, change**	**Total assets growth**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Recap_t/ TA	-0.1916	-0.2288	0.0469	0.0162	0.0702	-0.1412	0.2637
	(-0.85)	(-1.14)	(0.55)	(0.34)	(0.21)	(-1.11)	(0.68)
Recap_t-1/ TA	1.4252***	1.1749***	0.0824	0.3836***	0.7548***	-0.3722***	2.0550***
	(12.92)	(7.69)	(1.19)	(4.76)	(6.25)	(-3.62)	(10.24)
Shortfall/MVTA	-0.5157**	-0.5888*	-0.2512*	-0.3174**	-0.4471	0.1156	-1.3381***
	(-2.24)	(-1.92)	(-1.95)	(-2.52)	(-1.15)	(0.43)	(-2.95)
ROA	0.0133***	0.0051	-0.0026	-0.0021	0.0032	0.0030	0.0106
	(3.31)	(1.00)	(-0.96)	(-0.40)	(0.46)	(0.41)	(0.97)
Size	-0.0975***	-0.1052***	-0.0110	-0.0092	-0.0864*	0.0136	-0.2140***
	(-5.33)	(-4.11)	(-0.77)	(-0.65)	(-1.94)	(0.73)	(-3.34)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5839	0.5550	0.2704	0.4166	0.5368	0.2897	0.4901

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

To see how banks that should be recapitalized but are not behave, one can look at the effect of capital shortfall. Market implied capital shortfall at $t-2$ is included into regressions to control for the undercapitalization of banks at the time just before they may be recapitalized. The impact of capital shortfall on the change in loans, government securities and total assets is negative. Undercapitalized banks tend to grow slower or even shrink their assets. The coefficient on bank size implies that in general large banks grow slower. Bank fixed-effects control for bank specific factors that affect dependent variables in all time periods. Country specific year fixed effects capture the distress that is common to all banks in a country at a certain point in time.

Table 4: Effect of recapitalization on bank funding.

	Customer deposits, change (1)	**Interbank borrowing, change (2)**	**Senior LT debt, change (3)**	**Subordinated debt, change (4)**
Recap_t/ TA	0.0214	0.3137	-0.3572	0.0173
	(0.20)	(1.61)	(-0.91)	(0.99)
Recap_t-1/ TA	1.1503***	0.0808	0.0691	0.0023
	(7.67)	(0.19)	(0.97)	(0.12)
Shortfall/ MVTA	-0.3346*	-0.1930	-0.3665*	0.0085
	(-1.96)	(-1.07)	(-1.94)	(0.30)
ROA	0.0043	0.0024	0.0085*	-0.0003
	(0.93)	(0.84)	(1.77)	(-0.39)
Size	-0.0570**	-0.0438***	-0.0452***	-0.0014
	(-2.04)	(-2.95)	(-2.71)	(-0.45)
Country-year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
N observations	798	800	770	725
N banks	96	97	98	93
R2: within	0.4399	0.2467	0.3873	0.3563

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

The effects of recapitalizations on lending are economically significant. Since both the changes in lending and recapitalization amounts are weighted by total assets, the estimated coefficients can be interpreted as follows. Each euro of injected capital leads to 1.42 euro of additional gross loans and 0.38 additional investment in government securities. The mean recapitalization amount is 3.8% of total assets of a bank, which means that as a result of the recapitalization a typical bank increased lending by an amount equivalent to 5.396% of total assets. The average annual change in gross loans of recapitalized banks in the year after recapitalization amounted to 3.83% of total assets, which means that if they were not recapitalized, they would have

reduced lending. For comparison, the average change in loans in approximately the same period (2009 to 2013) of banks that were not recapitalized is between 0% and 3% of total assets.[32]

Table 4 reports the results on how recapitalizations affect banks' ability to raise different types of funding. The dependent variables are changes in the amount of funding sources weighted by total assets. In the year following a recapitalization, banks attract significantly more deposits. The effect on other types of funding – interbank borrowing, senior long term debt and subordinated debt – do not appear to be significant. The effect that recapitalized banks attract more deposits is also observed by Berger et al. (2014) on a sample of German banks between 1999 and 2009.

Table 5: Effect of recapitalization on measures of asset quality.

	Impaired loans/ Gr. loans	**Loan loss prov./ Gr. loans**	**Loan loss reserves/ Gr. loans**	**Loan charge-offs/ Gr. loans**	**Loan recoveries/ Gr. loans**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Recap_t/ TA	-0.0329	0.2665**	0.0624	0.0042	-0.0270*
	(-0.50)	(2.70)	(1.27)	(0.20)	(-1.86)
Recap_t-1/ TA	-0.1031	-0.0503*	0.1079**	0.0343**	-0.0106
	(-1.58)	(-1.77)	(2.34)	(2.27)	(-0.84)
Shortfall/ MVTA	0.5295***	0.0840**	0.1476***	0.0216	-0.0056
	(3.24)	(2.52)	(3.35)	(1.00)	(-0.36)
ROA	-0.0063***	0.0009	-0.0024**	-0.0004	0.0001
	(-3.00)	(1.28)	(-2.47)	(-0.37)	(0.23)
Size	0.0093	0.0031*	-0.0004	0.0016	-0.0010
	(1.45)	(1.96)	(-0.15)	(0.50)	(-0.51)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
N observations	700	792	764	362	295
N banks	89	95	95	69	60
R2: within	0.7988	0.6662	0.7916	0.3711	-0.0059

RECAP_t/TA is the sum of recapitalizations during year t, divided by the total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 5 presents the regression results on asset quality. The results suggest banks begin cleaning up balance sheets immediately when they are recapitalized and continue it in the subsequent year. In general over all time periods, banks with larger capital shortfall have higher ratios of impaired loans, loan loss provisions and loan loss reserves to total gross loans. In the year when a bank is recapitalized it makes significantly more loan loss provisions. In the year

[32] The averages of selected variables over time are reported in Table A13 and Table A14 in the Online Appendix available at www.uva.nl/profile/t.homar.

after the recapitalization it provisions less, while the loan loss reserves are still higher and can be used to offset the loan charge offs, which are significantly higher in the year after the recapitalizations. Loan recoveries tend to be lower in the year of recapitalization but do not differ afterwards.

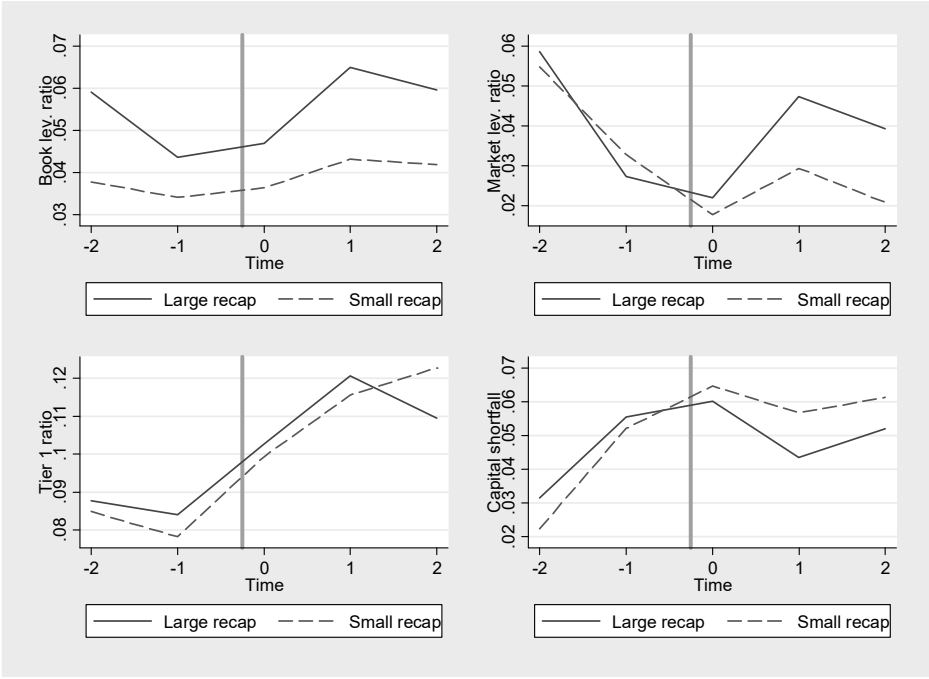


Figure 1: Mean book leverage ratio, market leverage ratio, Tier 1 ratio and capital shortfall for banks that received large or small recapitalizations relative to their capital shortfall.

Book leverage ratio is book value of equity divided by total assets. Market leverage ratio is market value of equity divided by the sum of market value of equity and book value of liabilities. Tier 1 ratio is Tier 1 capital divided by risk weighted assets. Capital shortfall is the market implied capital shortfall divided by the sum of market value of equity and book value of liabilities. Time *t=0* denotes the end of the year in which a bank was recapitalized. Bank recapitalizations were implemented between time *t=-1* and *t=0*. Most banks received the recapitalization toward the end of the year, which is marked by a grey vertical line. Red dashed lines plot the mean values for banks that received a SMALL recapitalization relative to their capital shortfall. These are banks in the bottom quartile of received recapitalization amount relative to their capital shortfall before recapitalization. Banks in the upper three quartiles of recapitalization relative to capital shortfall are classified as receiving a LARGE recapitalization (blue lines).

Giannetti and Simonov (2013) find that equity injections had a different effect on Japanese banks when they were large than in case when a bank was still undercapitalized after receiving an injection. Large recapitalizations increased lending, while small recapitalizations led to more evergreening of loans to zombie firms. To check for this effect, we distinguish between

banks that have received a small injection relative to their capital needs and banks that received a larger one. We sort banks according to the size of the received recapitalization relative to their capital shortfall before the recapitalization and create a dummy for banks in the bottom quartile. These banks received a recapitalization equal to less than 14.69% of their capital shortfall prior to the recapitalization. The median recapitalization amount is 26.05% of capital shortfall, while the mean is 61%.We classify banks in the bottom quartile as a group receiving small recapitalizations and those in the upper three quartiles as receiving large recapitalizations.[33]

To illustrate the differences between the two groups we plot mean capital and leverage ratios for both groups before and after recapitalization in Figure 1, and for a selection of outcome variables in Figure 2. Time $t=0$ marks the end of the year in which a bank is recapitalized. Most banks were recapitalized toward the end of the year, which is indicated with a grey vertical line in the graphs. Book leverage ratio, (book value of equity over total assets) is falling before recapitalization and increases after. The increase is noticeably larger for bank that get a large recapitalization. Similarly, market leverage ratio (market value of equity divided by the sum of market value of equity and book value of liabilities) increases substantially after large recapitalizations and less after small.[34] In contrast there is no visible difference between the two groups in Tier 1 ratio. For both the average Tier 1 ratio increases from approximately 8% at $t=-1$ to about 12% at $t=1$. Since Tier 1 ratio is computed over risk weighted assets, this suggest banks that receive smaller injections increase their risk weighted assets relatively less (or reduce them more) than those that receive larger amounts. Capital shortfall, which to a large extent resembles the inverse of market leverage ratio, decreases after recapitalization.

Figure 2 depicts gross loans, customer deposits, risk weighted assets and loan loss provisions for both groups of banks. For loans, deposits and risk weighted assets, we plot mean index values with the base at t=-1, which is at the beginning of the year in which recapitalizations are implemented. For loan loss provisions, mean values of the ratio are plotted. Banks that receive smaller recapitalizations exhibit a larger loan growth before the recapitalization year, whereas they increase gross loans less following the recapitalization. Interestingly, in the year of recapitalization customer deposits fall in banks that received small injections, while they increase in banks that got larger injections, suggesting that depositors do not perceive small recapitalizations to be sufficient to reassure them. A large recapitalization enables banks to increase risk weighted asset while following a small recapitalization, banks shrink their risk

[33] Recapitalization amounts relative to capital shortfall for all recapitalizations are reported in Table 2.

[34] The increase appears to happen from *t=0* to *t=1*, which is in the year after the recapitalization, and not in the year of recapitalization between *t=-1* and *t=0*. This is likely due to the fact that we do not observe the lowest point for market leverage ratio, which is presumably reached somewhere between *t=-1* and *t=0*, just before the recapitalization.

weighted assets. Furthermore, banks getting a large injection make more loan loss provisions in the year of recapitalization and need to provision less in the following year. In contrast, the increase in loan loss provisions is less pronounced and more gradual with a small injection.

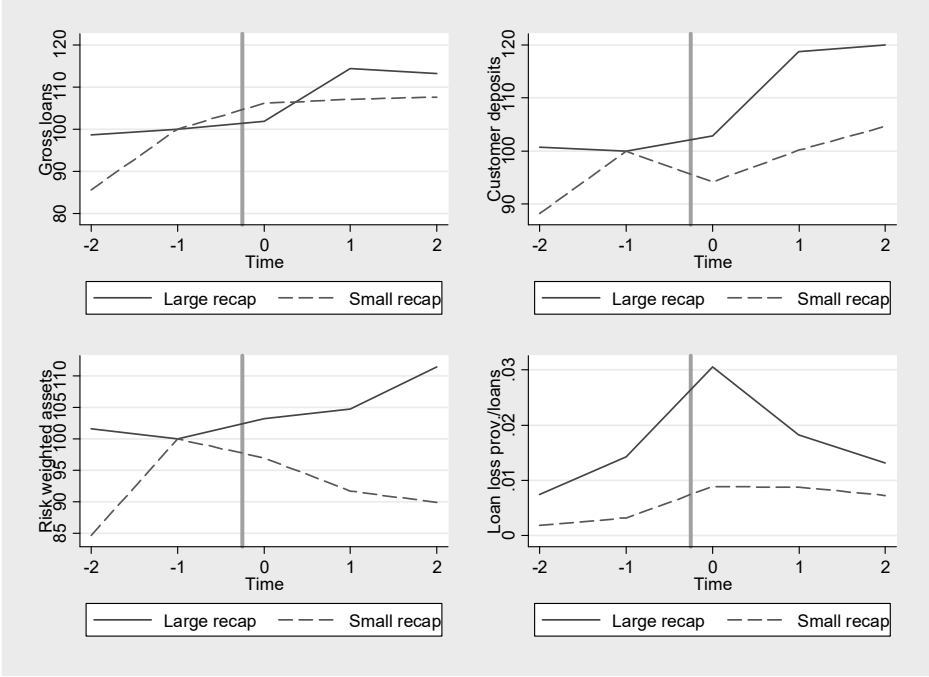


Figure 2: Mean index values of gross loans, customer deposits and risk weighted assets, and loan loss provisions to gross loans ratio for banks that received a large or a small recapitalization relative to their capital shortfall.

Time *t=0* denotes the end of the year in which a bank was recapitalized. Bank recapitalizations were implemented between time *t=-1* and *t=0*. Most banks received the recapitalization toward the end of the year, which is marked by a grey vertical line. For gross loans, customer deposits and risk weighted assets mean values of indices with the base at *t=-1* are plotted. For loan loss provisions ratio, means of actual values are plotted. Red dashed lines plot the mean values for banks that received a SMALL recapitalization relative to their capital shortfall. These are banks in the bottom quartile of received recapitalization amount relative to their capital shortfall before recapitalization. Banks in the upper three quartiles of recapitalization relative to capital shortfall are classified as receiving a LARGE recapitalization (blue line).

In Table 6 and Table 7 we investigate these effects in a regression framework. We interact the dummy for small recapitalizations with variables for recapitalization amount to allow for a different effect of injected equity when the injection is small relative to the capital shortfall. Table 6, which can be compared to Table 3, reports the results for lending and asset growth. Controlling for other factors, a small recapitalization leads banks to reduce gross loans. Banks

that receive a large recapitalization increase loans by a factor of 1.43 of the injected amount in the year after recapitalization, while banks that get a small recapitalization reduce the loans outstanding by a factor of 1.16 of the injected amount.

Table 6: Effect of recapitalization on lending and asset growth, with interaction term for small recapitalizations.

	Gross loans, change	Loans excl. interbank, change	Interbank lending, change	Govt. securities, change	Risk weighted assets, change	Risk w. assets/TA, change	Total assets growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Recap_t/ TA	-0.1976	-0.2407	0.0428	0.0186	0.0681	-0.1410	0.2502
	(-0.88)	(-1.22)	(0.51)	(0.39)	(0.20)	(-1.07)	(0.64)
Recap_t/ TA * small	1.5327	4.3468***	0.5317	-2.5564	-1.2831	1.6297	-2.2716
	(0.68)	(3.92)	(0.29)	(-1.33)	(-0.59)	(0.87)	(-0.28)
Recap_t-1/ TA	1.4335***	1.1795***	0.0881	0.3842***	0.7617***	-0.3777***	2.0950***
	(13.24)	(7.89)	(1.15)	(4.81)	(6.13)	(-3.64)	(9.93)
Recap_t-1/ TA * small	-2.5929*	-5.6053***	-1.9720	1.6934	-2.6540	1.8485	-10.7256**
	(-1.96)	(-3.87)	(-1.09)	(1.25)	(-1.06)	(0.61)	(-2.23)
Shortfall/ MVTA	-0.5031**	-0.5669*	-0.2384*	-0.3152**	-0.4296	0.1017	-1.2378***
	(-2.22)	(-1.87)	(-1.77)	(-2.44)	(-1.09)	(0.36)	(-2.75)
ROA	0.0131***	0.0045	-0.0028	-0.0017	0.0029	0.0032	0.0101
	(3.20)	(0.84)	(-1.03)	(-0.32)	(0.43)	(0.42)	(0.94)
Size	-0.0965***	-0.1025***	-0.0099	-0.0097	-0.0825*	0.0105	-0.2081***
	(-5.19)	(-3.95)	(-0.66)	(-0.67)	(-1.93)	(0.60)	(-3.31)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5846	0.5577	0.2717	0.4182	0.5377	0.2909	0.4926

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term SMALL is an indicator for a bank that received a small recapitalization given its shortfall. The indicator has value 1 for recapitalized banks that are in the bottom quartile of recapitalization relative to capital shortfall. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Similarly, they reduce loans excluding interbank lending. The coefficients with interaction term are not significant for interbank lending, holdings of government securities and risk weighted assets. For total assets the difference between small and large recapitalizations is substantial. These results suggest that it matters how large a recapitalization is relative the capital needs of a bank. For small recapitalizations relative to the capital shortfall, a larger recapitalization amount leads to a greater reduction in lending. Once the recapitalizations are large enough, the relationship becomes positive. A possible explanation is that if the

recapitalization is very small relative to the capital shortfall, it does not have much of an effect. If the recapitalization is a bit larger, but still far from what is needed for the bank to become adequately capitalized, the restructuring of the bank is done through cutting back on lending and reducing risk weighted assets. Only when recapitalizations are sufficiently big, a larger recapitalization amount results in a greater increase in lending. We also check whether the effects of recapitalizations differ when banks are divided into two groups at the median or at the top quartile of recapitalization amount relative to shortfall but do not find significant effects there.

Table 7: Effect of recapitalization on bank funding and measures of asset quality, with interaction term for small recapitalizations.

	Customer deposits, change	Interbank borrowing, change	Senior LT debt, change	Impaired loans/ Gr. loans	Loan loss prov./ Gr. loans	Loan loss reserves/ Gr. loans
	(1)	(2)	(3)	(5)	(6)	(7)
Recap_t/ TA	0.0237	0.3096	-0.3475	-0.0355	0.2664**	0.0617
	(0.22)	(1.59)	(-0.89)	(-0.54)	(2.69)	(1.25)
Recap_t/ TA * small	-4.6179***	-4.0234***	0.7248	-0.9785*	-0.3071***	-0.5429*
	(-2.99)	(-2.77)	(0.28)	(-2.02)	(-2.86)	(-1.90)
Recap_t-1/ TA	1.1547***	0.0917	0.0491	-0.0991	-0.0497*	0.1095**
	(7.93)	(0.21)	(0.65)	(-1.43)	(-1.69)	(2.28)
Recap_t-1/ TA * small	-1.4395	-3.9844	5.3268***	-1.9370***	-0.2143	-0.6648***
	(-0.71)	(-1.67)	(3.96)	(-4.17)	(-1.34)	(-2.99)
Shortfall/ MVTA	-0.3055*	-0.1432	-0.4199**	0.5483***	0.0871**	0.1548***
	(-1.74)	(-0.83)	(-2.21)	(3.20)	(2.51)	(3.33)
ROA	0.0043	0.0021	0.0088*	-0.0064***	0.0009	-0.0024**
	(0.94)	(0.76)	(1.83)	(-3.13)	(1.27)	(-2.45)
Size	-0.0541*	-0.0395***	-0.0486***	0.0113*	0.0033*	0.0003
	(-1.92)	(-2.84)	(-2.88)	(1.81)	(1.96)	(0.09)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	798	800	770	700	792	764
N banks	96	97	98	89	95	95
R2: within	0.4430	0.2525	0.3913	0.7998	0.6668	0.7924

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term SMALL is an indicator for a bank that received a small recapitalization given its shortfall. The indicator has value 1 for recapitalized banks that are in the bottom quartile of recapitalization relative to capital shortfall. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 7 presents the results with interaction term for funding sources and asset quality.[35] Bank that receive a small recapitalization suffer a significant drop in customer deposits and are able to borrow less on the interbank market in the year when the recapitalization is implemented. This suggests that too small recapitalizations raise doubts by depositors and investors, which makes it more difficult for the intervened banks to secure funding. In the year after recapitalization, however, these banks raise significantly more senior long term debt. The coefficients with interaction terms in regressions about asset quality show that with a small recapitalization banks report less impaired loans and make less provisions in the year of recapitalization. In the year after recapitalization they have lower impaired loans as well as lower

Table 8: Effect of recapitalization on lending and asset growth, with interaction term for low Tier 1 ratio after recapitalization.

	Gross loans, change	Loans excl. interbank, change	Interbank lending, change	Govt. securities, change	Risk weighted assets, change	Risk w. assets/TA, change	Total assets growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Recap_t/ TA	-0.2004	-0.3807*	0.1311	0.0115	0.7686***	-0.0710	0.5363
	(-0.55)	(-1.89)	(1.36)	(0.19)	(3.19)	(-0.32)	(0.86)
Recap_t/ TA * low	0.1851	0.4874*	-0.1851	0.0202	-1.0875***	-0.0771	-0.5155
	(0.44)	(1.98)	(-1.61)	(0.19)	(-4.71)	(-0.35)	(-0.78)
Recap_t-1/ TA	3.0715***	2.2568**	0.3601	0.4673**	2.1393***	0.1898	3.7946***
	(4.15)	(2.41)	(1.37)	(2.65)	(3.20)	(0.38)	(2.89)
Recap_t-1/ TA * low	-1.8714***	-1.1522	-0.3575	-0.0899	-1.8765***	-0.6664	-2.1182**
	(-3.26)	(-1.47)	(-1.39)	(-0.65)	(-3.88)	(-1.61)	(-2.08)
Shortfall/ MVTA	-0.5403**	-0.6010*	-0.2564**	-0.3197**	-0.4306	0.1158	-1.3775***
	(-2.28)	(-1.93)	(-2.04)	(-2.63)	(-1.11)	(0.41)	(-3.03)
ROA	0.0133***	0.0045	-0.0024	-0.0022	0.0047	0.0031	0.0106
	(3.19)	(0.93)	(-0.88)	(-0.40)	(0.63)	(0.41)	(0.94)
Size	-0.0979***	-0.1065***	-0.0108	-0.0093	-0.0816*	0.0142	-0.2136***
	(-5.26)	(-4.23)	(-0.76)	(-0.65)	(-1.82)	(0.73)	(-3.34)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	816	757	801	532	541	541	842
N banks	98	93	95	73	84	84	101
R2: within	0.5933	0.5609	0.2725	0.4168	0.5571	0.2932	0.4932

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term LOW is an indicator for banks with relatively low Tier 1 ratio after recapitalization. The indicator has value 1 for recapitalized banks that are in the bottom quartile of the distribution of Tier 1 ratio just after recapitalization. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

[35] Compared to Table 4 and Table 5 we omit results for subordinated debt, loan charge-offs and loan recoveries to combine the regressions about funding sources and asset quality in one table. The coefficients with interaction term are not significant in the omitted regressions.

loan loss reserves. These results imply that banks that get small recapitalizations tend to have better asset quality or that the recapitalization amount is too low to induce a serious balance sheet clean up.

As an alternative measure of undercapitalization, we look at Tier 1 capital ratio at the end of the recapitalization year. Instead of on the injected amount relative to capital needs, this measure is based on the outcome of the recapitalization. Banks with a higher Tier 1 ratio are better capitalized than those with a lower one. Again we sort banks into quartiles and create a dummy for banks in the bottom quartile with the lowest Tier 1 ratio. In Table 8 and Table 9 we interact the dummy with recapitalization amount to check whether the effect of injected recapitalization amount differs for banks with low Tier 1 ratio. The threshold between banks with low and high Tier 1 ratio is at 8.5 %.

Table 9: Effect of recapitalization on bank funding and measures of asset quality, with interaction term for low Tier 1 ratio after recapitalization.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Impaired loans/ Gr. loans (4)	Loan loss prov./ Gr. loans (5)	Loan loss reserves/ Gr. loans (6)
Recap_t/ TA	0.2555*	0.4808	-0.8112***	-0.0108	0.2623	0.1267***
	(1.81)	(1.67)	(-3.47)	(-0.18)	(1.59)	(3.75)
Recap_t/ TA * low	-0.5277***	-0.2753	0.8969***	-0.0268	0.0118	-0.1368***
	(-2.88)	(-0.81)	(4.10)	(-0.54)	(0.07)	(-3.20)
Recap_t-1/ TA	1.7910***	1.5544***	-0.0945	0.1941	-0.0383	0.3665***
	(3.04)	(2.76)	(-0.34)	(1.63)	(-0.67)	(9.70)
Recap_t-1/ TA * low	-0.8442*	-1.7584***	0.3600	-0.3465***	-0.0115	-0.3244***
	(-1.86)	(-6.16)	(1.14)	(-3.35)	(-0.48)	(-5.66)
Shortfall/ MVTA	-0.3472*	-0.2149	-0.3340*	0.5254***	0.0839**	0.1428***
	(-1.88)	(-1.20)	(-1.73)	(3.28)	(2.49)	(3.38)
ROA	0.0046	0.0027	0.0084*	-0.0062***	0.0009	-0.0023**
	(0.97)	(1.00)	(1.74)	(-3.02)	(1.35)	(-2.36)
Size	-0.0563*	-0.0438***	-0.0464***	0.0093	0.0030**	-0.0003
	(-2.03)	(-2.98)	(-2.76)	(1.50)	(2.09)	(-0.10)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	798	800	770	700	792	764
N banks	96	97	98	89	95	95
R2: within	0.4457	0.2643	0.3960	0.7996	0.6662	0.7971

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. The interaction term LOW is an indicator for banks with relatively low Tier 1 ratio after recapitalization. The indicator has value 1 for recapitalized banks that are in the bottom quartile of the distribution of Tier 1 ratio just after recapitalization. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 8 shows that banks with low Tier 1 ratio increase lending after recapitalization but significantly less than banks with higher Tier 1 ratio. The variable where banks with low Tier 1 ratio differ most is risk weighted assets. They shrink risk weighted assets in the year in which recapitalization is implemented and increase them slightly but significantly less than other banks in the following year. This effect is present also for total assets. The results are in line with the findings of Kok and Schepens (2013) who analyze adjustment of banks toward target equity and Tier 1 ratios and find that reshuffling of risk weighted assets is the main adjustment method, and is particularly important for seriously undercapitalized banks.

Table 9 displays results for bank funding and asset quality. Banks with low Tier 1 ratio after recapitalization suffer a drop in deposits in the year when the recapitalization is implemented and attract less deposits in the subsequent year than banks with higher Tier 1 ratio. They also borrow less on the interbank market. In terms of asset quality banks with low Tier 1 exhibit significantly lower ratio of loan loss reserves to gross loans than banks with high Tier 1 ratio.

4.6 Robustness checks

This section provides several robustness checks. Our main control of undercapitalization and distress is the market implied capital shortfall ratio. To check whether our results depend on using the SRISK shortfall as a measure of undercapitalization, we perform regressions with different leverage and regulatory capital ratios in place of capital shortfall. Table 10 displays the results. In the first column, the same estimation is reported as in the main results in Table 3 to facilitate comparison. In the next columns, market leverage, book leverage, Tier 1 and regulatory capital ratios are used instead of capital shortfall. None of them has a significant effect on lending, while the positive effect of bank recapitalizations remains significant in all specifications. Similarly, results in Table 11 show that the effect of recapitalizations on the change in customer deposits is robust to using different leverage ratios.[36]

In Chapter 6, I show that SRISK may underestimate capital shortfalls of banks with low market leverage ratio. They compare the losses in the stress scenario of the ECB/EBA 2014 stress test with losses implied by the SRISK stress scenario for 43 Eurozone banks and find that losses implied by SRISK are highly correlated with initial market leverage ratio of banks. They point at a possible problem of SRISK – because it is based on stock returns it may underestimate

[36] We perform regressions with leverage and capital ratios also with other dependent variables. Since leverage and capital ratios are almost never significant and the effects of recapitalizations are robust, we do not report these regressions.

bank losses in states where the entire bank equity is wiped out. If the losses of weakly capitalized banks in the stress scenario are underestimated, their shortfalls are consequently too small. In our dataset this seems to be the case for banks that received recapitalizations that were a multiple of their capital shortfall before the intervention. Banks with low market capitalization appear to be less distressed than they really are. For the analysis of the effects of recapitalizations this means that the estimated positive effect of recapitalizations could be too low if the negative effect on lending by the bank initial undercapitalization is not fully captured by the shortfall. As the regressions in Table 10 and Table 11 show the positive effect of recapitalization does not depend on using SRISK or any other measure of bank capitalization. If bank distress could be measured more accurately the positive effects of recapitalizations would presumably be even larger.

Table 10: Robustness check, leverage and capital ratios, effect on lending.

	Gross loans, change	**Gross loans, change**	**Gross loans, change**	**Gross loans, change**	**Gross loans, change**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Recap_t/ TA	-0.1916	-0.2228	-0.2185	-0.2521	-0.2533
	(-0.85)	(-0.96)	(-0.87)	(-0.98)	(-0.99)
Recap_t-1/ TA	1.4252***	1.4132***	1.3881***	1.3583***	1.3417***
	(12.92)	(11.58)	(10.17)	(9.07)	(9.24)
Shortfall/ MVTA	-0.5157**				
	(-2.24)				
Market leverage ratio		0.0623			
		(0.60)			
Book leverage ratio			-0.2765		
			(-1.28)		
Regulatory capital ratio				-0.1954	
				(-1.57)	
Tier 1 ratio					-0.1668
					(-1.14)
ROA	0.0133***	0.0142***	0.0148**	0.0140**	0.0147**
	(3.31)	(3.26)	(2.31)	(2.44)	(2.62)
Size	-0.0975***	-0.0962***	-0.1093***	-0.1033***	-0.1024***
	(-5.33)	(-4.23)	(-5.16)	(-3.42)	(-3.64)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
N observations	816	816	1112	862	868
N banks	98	98	100	91	93
R2: within	0.5839	0.5799	0.5254	0.5771	0.5715

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Table 11: Robustness check, leverage and capital ratios, effect on deposits.

	Customer deposits, change (1)	Customer deposits, change (2)	Customer deposits, change (3)	Customer deposits, change (4)	Customer deposits, change (5)
Recap_t/ TA	0.0213	0.0169	-0.0166	-0.0376	-0.0391
	(0.20)	(0.15)	(-0.22)	(-0.43)	(-0.42)
Recap_t-1/ TA	1.1503***	1.1371***	1.2132***	1.1645***	1.1580***
	(7.67)	(7.55)	(7.39)	(6.51)	(6.57)
Shortfall/ MVTA	-0.3344*				
	(-1.96)				
Market leverage ratio		0.1475*			
		(1.98)			
Book leverage ratio			-0.1025		
			(-0.66)		
Regulatory capital ratio				0.1110	
				(0.91)	
Tier 1 ratio					0.0494
					(0.45)
ROA	0.0043	0.0033	0.0014	-0.0035	-0.0023
	(0.93)	(0.74)	(0.48)	(-0.81)	(-0.59)
Size	-0.0570**	-0.0488	-0.0699***	-0.0717***	-0.0695***
	(-2.04)	(-1.63)	(-3.50)	(-3.15)	(-2.96)
Country-year FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
N observations	798	798	1092	853	860
N banks	96	96	99	89	91
R2: within	0.4399	0.4398	0.4268	0.4962	0.4637

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

The sample of analyzed banks runs from 2000 to 2013, while bank recapitalizations only occur after 2007. The observations before 2008 do not contribute to the estimation of coefficients of the effect of recapitalization but may possibly distort them. Furthermore, banks with zero capital shortfall may be too different from the recapitalized banks to be considered a part of the relevant control group.[37] On the other hand, the advantage of a broader sample and a longer time span is that more observations are available for the estimation of bank fixed effects and time fixed effects. To check whether the findings presented in the main results are robust to these concerns, we rerun regressions from Table 3, Table 4 and Table 5: (i) excluding time periods before 2008, (ii) excluding banks with zero capital shortfall and (iii) excluding both the early time periods and banks without shortfall. The results on the effect of recapitalizations remain robust in all three cases.

[37] Only one recapitalized bank (Oesterreichische Volksbanken AG) did not have a capital shortfall before it was recapitalized.

Table 12: Robustness check, effect of recapitalization on lending and asset growth, the estimation sample is limited to the period of 2008 to 2013 and banks with nonzero capital shortfall.

	Gross loans, change	Loans excl. interbank, change	Interbank lending, change	Govt. securities, change	Risk weighted assets, change	Risk w. assets/TA, change	Total assets, growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Recap_t/ TA	-0.0573	-0.1152	0.0397	-0.0216	0.1060	-0.1570	0.2787
	(-0.29)	(-0.64)	(0.33)	(-0.21)	(0.29)	(-0.76)	(0.64)
Recap_t-1/ TA	1.3577***	1.1143***	0.0953	0.3673***	0.7751***	-0.4909***	2.0826***
	(5.74)	(6.64)	(0.97)	(3.68)	(3.55)	(-3.54)	(5.03)
Shortfall/ MVTA	-0.7721**	-0.5750	-0.2901	-0.1757	-0.7915	0.1385	-0.2757
	(-2.15)	(-1.21)	(-1.17)	(-0.62)	(-0.84)	(0.25)	(-0.15)
ROA	0.0010	-0.0092	-0.0059*	-0.0090	-0.0011	0.0118	-0.0077
	(0.22)	(-1.28)	(-1.84)	(-1.07)	(-0.08)	(0.86)	(-0.33)
Size	-0.0968	-0.1212*	-0.0065	0.0124	-0.1265	0.0044	-0.2762*
	(-1.67)	(-2.10)	(-0.43)	(0.58)	(-1.29)	(0.09)	(-2.00)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N observations	372	349	372	251	312	312	372
N banks	82	81	82	64	73	73	82
R2: within	0.5082	0.4574	0.2533	0.5091	0.3773	0.2667	0.4552

Dependent variables are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

Because the results are similar, we only report those estimated on the smallest sample limited to the time period from 2008 to 2013 and banks with nonzero capital shortfall. Table 12 relates to Table 3; regressions in Table 13 can be compared to those in Table 4 and Table 5. Coefficients for bank recapitalizations remain significant and their size does not change much. The only noticeable difference is that the estimated effect of capital shortfall becomes less significant, which is expected given that the banks that remain in the sample are more similar to each other in terms of shortfall.

In the regressions so far, recapitalization amounts are weighted by total assets. Alternatively, recapitalization amounts could be weighted by capital shortfall. Weighting by total assets is more appropriate when each euro of injected equity is expected to have approximately equal effect on outcome variables. In contrast, weighting by capital shortfall is more appropriate when the rate for which incentives are improved is critical for the effect on outcome variables. To illustrate the conceptual difference, consider a bank with a capital shortfall equal to 2% of its assets that receives a recapitalization that also amounts to 2% of its assets. If recapitalization

Table 13: Robustness check, effect of recapitalization on bank funding and measures of asset quality, the estimation sample is limited to the period of 2008 to 2013 and banks with nonzero capital shortfall.

	Customer deposits, change (1)	Interbank borrowing, change (2)	Senior LT debt, change (3)	Impaired loans/ Gr. loans (4)	Loan loss prov./ Gr. loans (5)	Loan loss reserves/ Gr. loans (6)
Recap_t/ TA	0.0966	0.1708	-0.2592	-0.1065**	0.1890	0.0139
	(0.54)	(0.75)	(-1.38)	(-2.39)	(1.61)	(0.54)
Recap_t-1/ TA	1.1248***	0.0449	-0.0544	-0.0988	-0.0489*	0.1103**
	(4.11)	(0.09)	(-0.55)	(-0.91)	(-1.93)	(2.40)
Shortfall/ MVTA	-0.8279*	-0.1466	-0.2366	0.1577	0.1035	0.0247
	(-1.87)	(-0.39)	(-1.11)	(1.14)	(1.73)	(0.42)
ROA	-0.0073	0.0028	-0.0017	-0.0049	0.0043**	-0.0038
	(-1.26)	(0.45)	(-0.16)	(-0.87)	(2.89)	(-1.39)
Size	-0.0898*	-0.0271	-0.0596***	0.0072**	0.0057**	-0.0024
	(-1.96)	(-0.77)	(-4.15)	(2.16)	(2.51)	(-0.57)
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	367	370	345	328	366	358
N banks	81	82	78	76	81	81
R2: within	0.5724	0.2768	0.3114	0.8798	0.6569	0.8602

Dependent variables referring to funding are changes from year t-1 to t weighted by total assets. RECAP_t/TA is the sum of recapitalizations during year t, divided by total assets at t-2. RECAP_t-1/TA is the sum of recapitalizations during year t-1, divided by total assets at t-2. Shortfall/MVTA is the capital shortfall at t-2 divided by the market value of total assets at t-2. For definitions of other variables see Table 14 in the Appendix. In parentheses are t-statistics based on Driscoll and Kraay (1998) standard errors, which are robust against heteroscedasticity, autocorrelation and cross-sectional dependence. Significance levels of 10%, 5%, and 1% are denoted by *, **, ***, respectively.

amounts are weighted by total assets, the effect of such a recapitalization on lending is expected to be the same as the effect of a recapitalization of 2% of assets injected into a bank with a capital shortfall equal to 1% of its assets, controlling for the level of shortfall and other factors. In the other case when recapitalization amounts are weighted by capital shortfall, such an injection is expected to have the same effect as an injection equal to 1% of bank assets into a bank with a shortfall of 1%. We rerun the regressions from Table 3, Table 4 and Table 5 with recapitalizations weighted by capital shortfall instead of by total assets and report them in Table A2, Table A3 and Table A4 (Table 3 compares to Table A2 etc.). To conserve space, we report these tables and the tables of the following robustness checks in the Online Appendix. [38] Comparing the estimates weighted by total assets with those weighted by capital shortfall reveals no noticeable differences. The signs of significant coefficients are identical and their levels of significance are about the same.

Next, we rerun regressions from the main results in Table 3, Table 4 and Table 5 but define outcome variables as relative changes instead of changes weighted by total assets. Thus

[38] The Online Appendix is available at www.uva.nl/profile/t.homar

we look at growth rates of balance sheet components. The specifications with changes weighted by total assets provide information on which balance sheet components have increased or decreased most in absolute terms as a result of recapitalization, while outcome variables defined as relative changes are informative about which items have changed most compared to their initial value. The estimations with outcome variables defined as growth rates are reported in Table A5, Table A6, Table A7 and reflect those in the main results section.

In the main results we use country specific year fixed effects in addition to bank fixed effects. To check whether so many fixed effects may capture too much of the variation in outcome variables, we rerun regressions from Table 3, Table 4 and Table 5 with year fixed effects that are not country specific an report these estimations in Table A7, Table A8 and Table A9. In general the results are similar to those in the main results section. A few differences suggest that country fixed effects and year fixed effects that are not country specific fail to capture part of the distress to which all banks in a country were exposed at a certain time. This shows up in a negative and significant coefficient of the effect of recapitalization on lending in the year in which recapitalization is implemented, a negative effect on deposits and higher impaired loans as well as loan loss reserves in the recapitalization year. Furthermore, the size of the coefficients of capital shortfall tends to be larger, suggesting that when time specific country fixed effects are not included, a part of the general distress in the banking sector is attributed to capital shortfall of individual banks. All of these differences point to the explanation that if the specification does not control for country specific time fixed effects, the results on recapitalizations are polluted by the effect of banking sector-wide distress in a country.

As a final robustness check we report the regressions from Table 3, Table 4 and Table 5 estimated with commonly used White (1980) heteroscedasticity robust standard errors instead of Driscoll-Kraay (1998) standard errors, which are in addition to heteroscedasticity robust also against autocorrelation and cross-sectional dependence and thus preferable. Since Driscoll-Kraay (1998) standard errors are somewhat less well known, we estimate the main regressions also with White (1980) standard errors and report them in Table A10, Table A11, Table A12 (Table A10 compares to Table 3 etc.) The significance levels are in general similar. The values of t-statistics are sometimes higher and sometimes lower than in the main results. In general there are no noteworthy differences.

4.7 Conclusions

Bank recapitalizations are a common form of intervention in systemic banking crises. How large they should be, is often subject to fierce discussions as government equity injections

into banks can require a substantial increase in public debt, may lead to moral hazard and could create rents for bank insiders. This chapter analyzes how effective recapitalizations are in achieving their objectives at the micro level: do they increase lending, improve banks' ability to raise funding and induce them to clean up balance sheets? And more specifically, is the size of recapitalizations important for their success? Theory suggests there are two inefficiencies that recapitalizations can mitigate. Firstly, undercapitalized banks are likely to lend less or even foreclose on borrowers with whom they have developed valuable relationships in the past. The borrowers cannot simply switch to another bank; in particular in times of crisis this is difficult. Secondly, banks close to or below regulatory capital requirements are likely to evergreen loans to nonviable borrowers to avoid prompt recognition of losses.

We analyze bank recapitalizations on a dataset of publicly traded European banks in the period of 2000 to 2013. The dataset provides great variation in regulatory approaches, timing of intervention and recapitalization amounts. Banks that were similarly undercapitalized were subject to different treatment. To control for undercapitalization of banks at the time just before they are intervened, we use market implied capital shortfall of banks, computed from a systemic risk measure developed by Acharya et al. (2012), which enables us to compare recapitalized banks with those that are similarly distressed but were not recapitalized or received an equity injection of different size.

We find that recapitalizations are only effective if they are large enough. Banks that receive a sufficient recapitalization increase lending, attract more deposits and clean up balance sheets. In contrast, banks that receive a small recapitalization, relative to their capital shortfall, suffer a drop in deposits and interbank borrowing, reduce lending and shrink assets. Furthermore, banks that have a relatively low Tier 1 ratio after recapitalization because the injection was small given their capital needs, shrink risk weighted assets and lend less than those with a higher Tier 1 ratio after recapitalization.

The policy implications of our findings are that recapitalizations need to be large enough to lead to new lending instead of an adjustment through shrinking. Giannetti and Simonov (2013) obtain similar results on Japanese banks. They are able to distinguish between lending to creditworthy borrowers, which increases after sufficient recapitalizations, and zombie lending into which too small recapitalizations are channeled. Our contribution is to provide an analysis of recapitalizations on all main aspects of bank behavior: lending, funding and asset quality. The results show that bank recapitalizations affect all of them and suggest that recapitalizations are beneficial. There are many further questions to explore about the effect of recapitalizations. How much of the increase in lending benefits banks' existing borrowers and how much of it is

lending to new customers? Does recapitalization size also affect allocation across risk weight classes? More specifically, do banks that received large injections given their shortfall lend more to SMEs than those that are recapitalized less? Such analysis would require loan level data or very detailed bank balance sheet data – topics for future research.

4.8 Appendix

Table 14: Variable definitions.

Variable	Description	BankScope WRDS code
Total assets	Book value of total assets	data2025
Book equity	Book value of equity	data2055
Market capitalization	Market value of equity. Source V-Lab webpage (Acharya, Engle and Richardson 2012)	
Market value of total assets	Market value of total assets is computed as the sum of market value of equity and book value of total liabilities.	
Size	Logarithm of total assets.	
SRISK	SRISK is a measure of systemic risk provided by Acharya, Engle and Richardson (2014). It is the dollar value of market implied capital shortfall that a bank would realize in case of a shock to the economy that would cause a 40% drop in the broad stock market index over a period of 6 months. The values are obtained from V-Lab webpage. The benchmark capital requirement is that a bank should have enough capital such that after the shock its market leverage ratio is at least 5%. A positive value means that a bank has too little capital, while a negative value indicates that a bank has more capital than necessary to be sufficiently capitalized in case of a shock.	
Capital shortfall/ MVTA	Capital shortfall, defined as SRISK divided by market value of total assets if SRISK is positive and zero otherwise.	
Recap/ TA	The sum of bank recapitalizations during a year divided by total assets at the end of the previous year.	
Recap/ shortfall	The sum of bank recapitalizations during a year divided by the capital shortfall at the end of the previous year.	
Recap year	Year when a recapitalization was implemented.	
Market leverage ratio	Market value of equity divided by market value of total assets	
Book leverage ratio	Book equity divided by total assets	
Regulatory capital ratio	Total regulatory capital divided by total assets	data4008
Tier 1 ratio	Tier 1 capital divided by total assets	data4007
Loans	Net loans are denoted simply as "loans". They are equal to gross loans reduced for loan loss reserves.	data2000
Gross loans	Gross loans are in contrast to net loans not reduced for loan loss reserves.	data2001
Loans excl. interb. lending	Net loans excluding loans and advances to banks	data2000-data2180
Interbank lending	Interbank lending (loans and advances to banks)	data2180
Government securities	Holdings of government securities	data11215
Customer deposits	Total customer deposits	data2031
Interbank borrowing	Interbank borrowing (deposits from banks)	data2185
Senior LT debt	Senior debt with maturity longer than 1 year	data11590
Subordinated debt	Subordinated debt	data11600
Impaired loans	Impaired loans	data2170
Loan loss provisions	Loan loss provisions (P&L item)	data2095
Loan loss reserves	Loan loss reserves (balance sheet item, it increases when loan loss provisions are made or when some impaired loans are recovered and decreases when loans are charged off)	data2070
Loan charge offs	Loan charge-offs	data10200
Loan recoveries	Loan recoveries	data30080

The table provides variable names, their definitions or short descriptions, and for BankScope variables the item under which the variable is reported in BankScope Financials database provided by WRDS.

Chapter 5
What Drives Forbearance

5.1 Introduction

A bank can deal with distressed borrowers in a number of ways. It can foreclose a troubled loan and seize the collateral. Alternatively, it may give the borrower concessions in the form of a delay of repayment or by refinancing the loan, which are known as forbearance. If a borrower's problems are liquidity-related, forbearing the loan, may be the optimal decision. When the problems are solvency-related, foreclosure or debt restructuring are better options. In particular in case a borrower has so much debt that its incentives are distorted i.e. there is a debt overhang problem (Myers 1977; Admati, DeMarzo, et al. 2013), restructuring the loan and offering a debt relief can maximize the expected repayment.

Nevertheless, a bank may forbear on borrowers with solvency problems to avoid selling the collateral at depressed prices or the increase in provisions as a result of recognizing the loan as a nonperforming exposure. Such forbearance can be seen as renegotiation failure – the maturity of the loan is extended but the borrower is stuck with too high leverage, which leads to a lower expected repayment than with a debt relief. It presents a misallocation of the lender's resources, effectively shifting the funds that could be granted as a new loan to a good creditor towards an inefficient borrower that ends up bankrupt in the future.

In the extreme case, forbearance enables banks to defer the losses that are associated with nonperforming loans ad infinitum, a practice called evergreening, and thus distort their own reported solvency and profitability (see Watanabe (2010) drawing on evidence from Japan and more generally (Diamond and Rajan 2011)). This is particularly acute in the aftermath of a financial crisis, as illustrated in Huizinga and Laeven (2012). Incentive schemes linked to bank profitability might amplify this problem, as argued by Eisfeldt and Rampini (2008). If this is done systematically by banks in a region, it might result in systemic risk due to the lack of confidence in the entire banking sector, with adverse effects on bank funding. Furthermore, it might hamper growth due to a credit squeeze relating to new loans. Japan's lost decade in the

aftermath of the severe banking crisis there provides a powerful illustration of the economic consequence of forbearance lending or zombie lending. The first studies documenting forbearance treat the Japanese crisis; see Baba (1996), Sekine, Kobayashi, and Saita (2003), Peek and Rosengren (2005) and Caballero, Hoshi, and Kashyap (2008). Outside Japan, the problem has received little attention: While there exists indirect empirical evidence of forbearance (Brown and Dinc 2009), direct evidence is scarce.

The Japanese experience has often been cited as a warning in Europe, reminding governments and regulators of the costs of inaction against balance sheet opaqueness and weak banks. The stock market valuation of European banks reflected a low level of confidence in the reported book values, with most banks showing price/book ratios far below one. Yet, the extent of forbearance and asset misreporting by European banks was very poorly documented prior to the ECB Comprehensive Assessment, and neglected in the academic discussion beyond policy relevance[39]. Bruche and Llobet (2014) devise an institutional setup based on contract theory inducing banks to reveal problematic loans. The lack of empirical studies is explained by the lack of a reliable proxy for forbearance - by definition misreporting of asset values is not reported.[40]

The ECB Comprehensive Assessment (CA), entailing a careful review of banks' balance sheets aiming to harmonize reporting standards, in particular with respect to the treatment of problematic loans, and a stress test aimed to shed light on bank vulnerability in general. It establishes a common benchmark for pricing assets so that deviations in asset values revealed by the asset quality review (AQR) can be interpreted as mispricing. One of the key differences of the AQR methodology compared to accounting standards is that forbearance measures are defined precisely and used as a trigger to classify an exposure as nonperforming. Therefore the AQR adjustment represents a unique measure of forbearance allowing us to identify the main variables associated with banks misreporting of asset values. Taking the reported corrections to asset valuation in the sample of investigated banks at face value, we try to identify drivers behind forbearance. It is the first study that empirically analyses forbearance across Europe using direct evidence, because previously no direct information on this phenomenon was available.

[39] European banking authority published technical standards (2014), the ESRB Advisory Scientific Committee (2012) and the (Bank of England 2011 and 2013) published a study and a chapter in the financial stability review devoted to the problem of forbearance.

[40] The most notable investigations on forbearance relied on identifying forbearance via borrower characteristics and information on outstanding loans (from corporate finance data, see (Sekine, Kobayashi, and Saita 2003)) or combining borrower characteristics, lender characteristics and data on loans outstanding to individual firms from individual lenders (Peek and Rosengren 2005); Such a dataset is not available for Europe.

In section 5.2 we provide some background about the CA, definitions of forbearance and formulate the hypotheses. Section 5.3 describes data. We present the results in section 5.4 and discuss robustness checks in section 5.5. Section 5.6 concludes.

5.2 Measuring forbearance

The ECB comprehensive assessment, carried out in 2014 on 130 Eurozone banks in preparation for common bank supervision, consisted of two parts: an asset quality review (AQR) and a stress test. The AQR was a point-in-time assessment of the accuracy of bank asset carrying values as of 31 December 2013. AQR methodology used to determine adjustments of bank asset values was based on accounting standards and included additional concepts to insure consistency across banks. In cases where more than one approach was consistent with accounting rules, the AQR prescribed a favored approach based on prudential and economic logic. Banks were required to reflect the adjustments in their accounting statements only if they were in breach of accounting rules. With respect to the treatment of nonperforming exposures (NPE), in particular forborne NPE, the International Financial Reporting Standards (IFRS) allow room for discretion and thus do not insure banks report forborne loans as NPE. In contrast the AQR definition of NPE captures forborne exposures. In the following paragraphs we provide the definitions of nonperforming and forborne exposures, and explain to what extent results of the AQR can be interpreted as measures of forbearance.

According to International Accounting Standards (IAS 39) an asset is impaired if and only if there is objective evidence of impairment in the form of a "loss event" that has impact on the estimated future cash flows of the asset. Losses expected as a result of future events are not recognized. Objective evidence of a loss event among others includes *"significant financial difficulty of the issuer or obligor*," and "*the lender, for economic or legal reasons relating to the borrower's financial difficulty, granting to the borrower a concession that the lender would not otherwise consid*er"[41]. The former is the main criterion for a loan to be classified as nonperforming; the latter indicates forbearance.

In the AQR a "simplified EBA approach" was used to define nonperforming exposures (NPE). The main difference compared to the accounting standards is that a loss event is not required and that forbearance is defined more precisely. A nonperforming exposure is defined as[42]:

- every material exposure that is 90 days past due even if it is not recognized as defaulted or impaired;

[41] IAS 39, paragraph 59. Parts of IAS that are included in IFRS are still referred to as IAS rather than as IFRS.
[42] See AQR Phase 2 Manual p. 46.

- every exposure that is impaired according to the IFRS or national accounting standards
- every exposure that is in default according to CRR[43]

An exposure is classified as nonperforming if it meets the definition above. Forborne exposures are covered in this definition indirectly. The AQR identified forborne NPE by using the EBA (European Banking Authority) technical standards as an impairment trigger for IAS 39 loss event.[44] Effectively, the very general IAS 39 definition of forbearance was refined by the detailed EBA definition, under which forborne exposures are debt contracts to which forbearance measures have been extended. Forbearance measures are concessions towards a debtor facing financial difficulties and consist of the following[45]:

(a) a modification of the previous terms and conditions of a contract the debtor is considered unable to comply with due to its financial difficulties ("troubled debt") to allow for sufficient debt service ability, that would not have been granted had the debtor not been in financial difficulties;

(b) a total or partial refinancing of a troubled debt contract, that would not have been granted had the debtor not been in financial difficulties.

Exposures are treated as forborne if a concession has been made irrespective of whether any amount is past-due. Exposures are treated as forborne even if the debtor is not in financial difficulties when:

(a) a modified contract was classified as non-performing or would in the absence of modification be classified as non-performing;

(b) the modification made to a contract involves a total or partial cancellation by write-offs of the debt;

(c) the institution approves the use of embedded forbearance clauses for a debtor who is under non-performing status or who would be considered as nonperforming without the use of these clauses;

(d) simultaneously with or close in time to the concession of additional debt by the institution, the debtor made payments of principal or interest on another contract with the institution that was non-performing or would in the absence of refinancing be classified as non-performing.

In addition there is a rebuttable presumption that forbearance has taken place when:

(a) the modified contract was totally or partially past-due by more than 30 days (without being non-performing) at least once during the three months prior to its modification or would be more than 30 days past-due, totally or partially, without modification;

[43] Capital Requirements Regulation (EU) No 575/2013

[44] See AQR Phase 2 Manual p. 115 and EBA/ITS/2013/03/rev1. The EBA technical standards were later (on 9 January 2015) adopted by the European Commission as Regulation (EU) 2015/227, which requires banks to report NPE and forborne exposures to their competent authorities. Regulators will be able to use this data to monitor the extent of forbearance.

[45] We summarize the main points of the definition. For a complete definition see EBA/ITS/2013/03/rev1 or Regulation (EU) 2015/227.

(b) *simultaneously with or close in time to the concession of additional debt by the institution, the debtor made payments of principal or interest on another contract with the institution that was totally or partially 30 days past due at least once during the three months prior to its refinancing;*

(c) *the institution approves the use of embedded forbearance clauses for 30 days past-due debtors or debtors who would be 30 days past-due without the exercise of these clauses.*

EBA distinguishes between performing and nonperforming forborne exposures. The AQR focused on nonperforming exposures. For a forborne exposure to be classified as an NPE in the AQR it has to be classified as forborne and as nonperforming according to EBA technical standards, which means it is forborne based on the conditions listed above and it is past-due more than 90 days or *"the debtor is assessed as unlikely to pay its credit obligations in full without realisation of collateral, regardless of the existence of any past-due amount or of the number of days past due."*

To sum up, by using the EBA definition of forborne exposures as an impairment trigger, the AQR adjustment of NPE corrects the NPE reported by banks for forborne exposures so it can be used as a measure of forbearance.

An ideal measure of forbearance would include only forborne exposures. AQR adjustment of NPE, however, also includes the change in NPE that are not forborne based on the definition above. Such exposures are of two types. First, there are exposures that are 90 or more days past-due without a loss event and without forbearance measures. Strictly speaking, these are not forborne exposures. However, loose policies concerning the recognition of nonperforming loans are very similar to the concept of forbearance, although the loan terms are not renegotiated. Effectively, loose policies have the same effect on banks' balance sheets, namely avoidance of provisioning. Secondly, there are exposures less than 90 days past-due that banks did not classify as impaired but are considered NPE based on AQR methodology, which specifies minimum triggers for IAS 39 loss event to harmonize treatment of NPE across banks. We argue that adjustment of such NPE constitutes only a minor part of the AQR adjustment as the triggers for this type of NPE do not differ much from existing definition in IAS 39.[46]

In addition to reviewing NPE, AQR also examined banks' provisioning. The AQR adjustment of provisions includes adjustment of provisions on nonperforming as well as performing exposures. Hence it can be interpreted as the extent of underprovisioning in general, not only due to forbearance. A more precise measure of underprovisioning due to forbearance is available for corporate loans where the AQR reports the imposed coverage ratio on newly classified NPE to corporates. Multiplying the coverage ratio with the adjustment of corporate

[46] For some banks (22 out of 130) that use local accounting standards rather than IFRS, harmonization of reporting of NPE that are not forborne could represent a larger part of the adjustment. We address this concern in the robustness checks.

exposures gives the increase in provisions due to the recognition of (mostly forborne) corporate NPE. The total AQR adjustment consists of the adjustment of provisions on credit exposures and valuation adjustment of other assets as well as the impact of tax, risk protection and insurance that would occur as a result of adjustments in asset values. We use adjustment of NPE, increase in provisions due to newly classified corporate NPE, adjustment of provisions and the aggregate AQR adjustment as proxies for forbearance. The first two measure forbearance more precisely. The latter two are broader.

Forbearance occurs when borrowers have financial difficulties and banks have incentives to forbear the problematic loans instead of foreclosing on them. Thus the extent of forbearance can be explained by two types of factors: (i) those that drive nonperforming loans and (ii) variables capturing bank incentives to forbear on borrowers. The determinants of nonperforming loans have recently been analyzed by Messai and Jouini (2013) for banks in Italy, Greece and Spain for the period of 2004 – 2008 and by Louzis, Vouldis, and Metaxas (2012) for banks in Greece. Both studies confirm findings from the literature on NPLs (see Nkusu (2011), Beck, Jakubik, and Piloiu (2013) and Quagliariello (2007) for recent examples) namely that macroeconomic variables, GDP growth rate, unemployment rate, lending rates and public debt level are important drivers. A theoretical foundation for this intuitive finding is offered by Williamson (1987). Furthermore, micro-variables, in particular measures of bank weakness, are likely to capture incentives of banks to forbear. Homar and Van Wijnbergen (2014) provide a model explaining how the level of bank capital affects bank decisions to forbear vs liquidate bad loans.

We examine the following hypotheses:

- *Hypothesis 1: Banks exposed to countries with worse macroeconomic conditions are more likely to engage in forbearance.*
- *Hypothesis 2: Banks are more likely to engage in forbearance where the supervisory environment permits them to do so.* As argued by the ESRB advisory scientific committee (2012) and Huizinga and Laeven (2012), forbearance practices are more likely to be found where bank supervisors condone them, thus in a way forbearing banks.
- *Hypothesis 3: Forbearance occurs where collateral values have fallen significantly.* A motive for forbearance is to avoid the losses associated with the sale of the underlying collateral at depressed values, leading to more forbearance when the value of collateral is lower.
- *Hypothesis 4a: Weak banks are more likely to engage in forbearance than strong banks (balance sheet based).*

- *Hypothesis 4b: Weak banks are more likely to engage in forbearance than strong banks (market based).*

5.3 Data and descriptive statistics

Using the outcomes of the AQR as measures of forbearance, we define the following dependent variables:

- **AQR adjustment of nonperforming exposures (NPE) / total credit exposures**: Change in nonperforming exposures ratio due to the outcome of the AQR (ECB communication variable E.D1 – E.A1 or E.B1 + E.C1)[47] is a proxy for the extent of forborne exposures.
- **AQR adjustment of residential real estate (RRE) NPE / RRE exposures**: (ECB communication variable E.D6 – E.A6 or E.B6 + E.C6)
- **AQR adjustment of corporate NPE / corporate exposures**: (ECB communication variable E.D8 – E.A8 or E.B8 + E.C8)
- **AQR adjustment of provisions for credit exposures / risk weighted total credit exposures**: Increase in provisioning for credit exposures due to the outcome of the AQR (ECB communication variable D.F1). It also includes changes in provisioning on existing nonperforming exposures. Therefore it moves away from the original meaning of forbearance, while capturing more accurately the under-provisioning and related weakness in the banking system due to problem loans and zombie lending.
- **AQR adjustment of provisions for RRE exposures / risk weighted RRE exposures**: (ECB communication variable D.F6).
- **AQR adjustment of provisions for SME exposures / risk weighted SME exposures**: (ECB communication variable D.F5).[48]
- **AQR adjustment of provisions for corporate exposures / risk weighted corporate exposures**: (ECB communication variable D.F8).
- **AQR adjustment of corporate NPE multiplied by imposed coverage ratio on corporate NPE** (ECB communication variables E.D1-E.A1)*E.J17) captures the increase in provisioning due to newly classified NPE, assuming constant imposed coverage ratio. It measures the extent of under-provisioning because of forbearance more precisely than the adjustment of provisions as it does not include adjustment of provisions on existing NPE. It is only available for corporate exposures and not for other types or credit exposures in general.

[47] The codes refer to the data file accompanying the Aggregate Report on the Comprehensive Assessment.
[48] For exposures to SMEs only adjustment of provisions is reported; adjustment of NPE is not available.

- **AQR adjustment / total risk exposure**: Aggregated adjustments of bank assets due to the outcome of the AQR (ECB communication variable B2) measures the impact of AQR on bank Tier 1 capital. It includes adjustment of provisions for credit exposures, adjustment of values of other exposures e.g. derivatives and takes into account the effects of taxes, insurance and risk protection on the impact on Tier 1 ratio.

The AQR results report adjustments of NPE as ratios computed with balance sheet values of exposures i.e. the book value of nonperforming exposures is divided by the book value of total exposures for each category of exposures. Adjustments of provisions on the other hand are reported as nominal. We scale provisions of each type by risk weighted exposures of the relevant type. We use the risk weighted amounts because AQR results do not report breakdown of exposures in nominal value. Scaling by risk weighted values implies that the adjustment of provisions is expected to be proportionally larger for assets with higher risk weights. In robustness checks, we scale provisions for credit exposures by gross loans. We cannot do the same for RRE and corporate exposures as for those the data on their nominal amounts is not available in the AQR results. In other sources of bank balance sheet data it is not available for a sufficient number of banks. Similarly as provisions for credit exposures, we scale aggregate AQR adjustment by risk weighted assets in the main analysis and by total assets in robustness checks.

For adjustment of provisions on RRE, SME and corporate exposures, we set the adjustment to missing if a bank does not have any exposure of that type in order to distinguish between banks that have provisioned adequately and those where the adjustment of provisions is equal to zero because they did not have any exposures a certain asset class.

Next, we briefly discuss the explanatory variables as grouped by hypothesis.

With regard **to hypothesis 1** we use several variables describing the **macroeconomic conditions** in countries. For some variables we construct values weighted by exposure of banks to different countries to account for the fact that banks are likely to be affected by macroeconomic conditions not only in the country of their headquarters but also in countries where they have asset exposure – i.e. the effect of macroeconomic conditions in a particular country on a bank is assumed to be proportional to the exposure of the bank to that country relative to the total assets of the bank.[49] The list of macroeconomic variables is the following:

[49] For details about weighting macroeconomic variables by bank exposures see the Appendix on page 99.

- Real GDP growth, 5 year cumulated and weighted by bank exposures (Source: IMF World Economic Outlook)
- Sovereign bond yield, average of monthly observations for 2013 (Source: Bloomberg)
- Expected default frequency (EDF) of nonfinancial firms, country benchmark, average over firms weighted by total assets, average of monthly observations for 2013, weighted by bank exposures (Source: KMV – Moody's; obtained through ECB Statistical Data Warehouse (SDW))
- Unemployment rate, 3 year average (Source: Eurostat, obtained through ECB SDW)

With regard to **hypothesis 2** we draw on a set of indices describing the quality of bank supervision as constructed by Barth, Caprio, and Levine (2012), based on a survey. Higher index levels imply tighter regulation.

- The bank activities restrictions index describes how much activities of banks are restricted to providing core banking services. The index is higher when banks are for example prohibited from engaging in securities underwriting, brokering or dealing, insurance underwriting, real estate investment or if banks are not allowed to own nonfinancial firms.
- The capital regulatory index is higher the more stringent regulatory requirements for holding capital are. It also measures how narrowly capital is defined.
- The supervisory power index measures whether supervisory authorities have the power to prevent and correct problems. For example, the index is higher if authorities can restructure and reorganise troubled banks or declare a deeply troubled bank insolvent.
- The private monitoring index is high when financial statements issued by a bank have to be audited, when a large share of the 10 largest banks is rated by international rating agencies, when there is no explicit deposit insurance scheme and if bank accounting fulfils certain requirements.
- The moral hazard mitigation index is based on Demirguc-Kunt and Detragiache (2002), who use principal components analysis on quantified features of explicit deposit insurance systems. These features include: foreign currency deposits covered, interbank deposits covered, type of funding, source of funding, management, membership and the level of explicit coverage.

Hypothesis 3 is tested with a measure of the size of the shock to collateral values:
Peak to trough drop in residential house prices, computed over a 5-year period (Source: ECB).

Hypothesis 4a is analyzed drawing on balance sheet information on solvency ratios and bank-specific variables. Some balance sheet variables are from the data published together with the report about the Comprehensive Assessment (ECB 2014a). Additional variables are from SNL and BankScope. SNL and BankScope are only used simultaneously for a bank when total assets in both datasets do not differ by more than 10%.

- Book leverage ratio: book value of equity divided by total assets (Source: CA report).
- Tier 1 ratio (Source: CA report).
- Impaired loans ratio: impaired loans over gross loans (Source: SNL, BankScope)

As control variables we use:

- ROA (Return on average assets) (Source: SNL, BankScope).
- Bank size, measured as the logarithm of total assets (CA report).
- RWA to total assets ratio (CA report).

Hypothesis 4b is examined using market data:

- Bank 5 year CDS spreads, average over end-of-month observations in 2013 (Source: Bloomberg).
- Bank stock returns for the period 2011-2013 (Source: Bloomberg)[50].
- Bank stock 4-factor alpha: average daily abnormal return over the period 2011-2013, computed as the intercept from the Carhart (1997) four factor asset pricing model, which builds on the Fama-French (1993) three factor model and augments it with another factor capturing the momentum effect. We use the return on Eurstoxx50 as a proxy for market return and the German 5-year government bond yield as the risk free rate. The other three factors are taken from Andrea Frazzini's data library[51].

The sample of banks subject to the CA initially consists of the 130 banks; we remove four banks[52] where we have no observations on the explanatory variables in the most basic setup. The descriptive statistics of the full sample are displayed in Table 1. Most explanatory variables are available for at least 120 banks, which represent 96% or more of total assets of banks that were analyzed in the CA. For variables based on market data the coverage is more limited and

[50] For variables based on stock returns, only stocks are considered that that have zero returns on less than 50% of the trading days. Stocks that have zero returns on more days may have been suspended from trading or are highly illiquid and thus not suitable for analysis.

[51] Available at https://www.aqr.com/library/data-sets/the-devil-in-hmls-details-factors-daily (Asness and Frazzini 2013)

[52] Deutsche Bank, Malta, AB SEB Bankas, Latvia, AB DNB Bankas, Latvia and Swedbank AB, Latvia, jointly representing 0.01% of sample assets.

includes about 40 banks, which account for 50% to 67% of total banking assets. To provide some indication of the explanatory power of the variables later used in regressions, Table 1 also reports R squared of univariate regressions where AQR adjustment of nonperforming exposures and adjustment of provisions for credit exposures are dependent variables and explanatory variables are included into regressions individually.

Table 1: Descriptive statistics

Variable	Mean	St. dev.	Min	Median	Max	N	Coverage of bank assets [%]	R2: Adj. NPE	R2: Adj. prov.
Dependent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AQR adjustment	0.6609	0.9388	0.0000	0.3086	5.8013	130	100.00		
AQR adj. NPE	1.8832	2.6471	-4.4730	1.1414	13.84	119	96.18		
AQR adj. RRE NPE	0.3572	2.1344	-10.53	0.0815	7.7850	80	78.56		
AQR adj. corp. NPE	3.1973	3.8848	-3.4109	1.9416	17.85	114	94.78		
AQR adj. credit prov.	0.8458	1.2252	0.0000	0.3307	6.2705	130	100.00		
AQR adj. RRE credit prov.	0.7593	2.2457	0.0000	0.0000	18.67	105	92.79		
AQR adj. SME credit prov.	1.1724	2.9429	0.0000	0.0000	15.83	98	87.78		
AQR adj. corp credit prov.	1.3187	2.0698	-0.0000	0.4955	12.84	128	99.52		
AQR adj. corp. NPE * coverage	0.0048	0.0101	-0.0252	0.0024	0.0794	107	92.55		
Macroeconomic variables									
GDP growth, 5 year	0.0354	0.0632	-0.1979	0.0437	0.1801	129	99.99	0.0030	0.0997
Govt. bond yield	0.0220	0.0199	0.0063	0.0116	0.0990	111	98.89	0.1399	0.3501
EDF nonfin. sector	0.0114	0.0188	0.0016	0.0064	0.1088	117	99.52	0.0480	0.0902
Unemployment, 3 year av.	0.1123	0.0567	0.0481	0.0975	0.2411	121	90.02	0.0038	0.0205
House prices, peak to trough ch.	0.0921	0.0863	0.0000	0.0622	0.2627	128	99.82	0.0030	0.0407
Quality of bank supervision									
Bank activity restr. ind.	5.7264	1.1502	4.5000	5.2500	7.7500	127	99.93	0.0237	0.1560
Capital regulatory ind.	6.5787	1.0428	4.8500	6.7500	8.7500	127	99.93	0.0111	0.0829
Supervisory power ind.	9.9372	1.6327	7.0000	9.5000	13.50	127	99.93	0.1145	0.0136
Private monitoring ind.	7.7992	0.7203	6.5000	7.5000	10.00	127	99.93	0.0000	0.0173
Moral hazard mitigation ind.	1.7241	0.6427	0.5000	2.0000	2.7500	127	99.93	0.0581	0.0196
Bank balance sheet variables									
IFRS	0.8268	0.3799	0.0000	1.0000	1.0000	127	99.90	0.0047	0.0739
Total assets	169	303	0.5670	54.18	1,640	130	100.00	0.0417	0.0205
Tier 1 ratio	0.1367	0.0561	-0.0370	0.1225	0.3728	127	98.57	0.0174	0.0101
Common equity/ TA	0.0648	0.0721	0.0000	0.0522	0.7870	130	100.00	0.0424	0.0002
ROA	-0.0026	0.0190	-0.0788	0.0017	0.0264	126	99.73	0.0386	0.0741
ROE	-0.0818	0.4285	-2.3920	0.0302	0.3189	126	99.73	0.0402	0.0796
Gross loans/ TA	0.5866	0.2088	0.0215	0.6326	0.9691	122	98.21	0.0004	0.0918
RWA/ TA	0.4529	0.1995	0.0014	0.4502	1.0991	130	100.00	0.0293	0.1081
Net interest income/ RWA	0.0307	0.0161	0.0038	0.0269	0.0853	109	71.41	0.0349	0.0003
Cost to income ratio	0.7002	0.3823	0.1327	0.6176	2.2674	114	78.25	0.0040	0.0000
Impaired loans ratio	0.1078	0.1069	0.0000	0.0741	0.4081	108	92.15	0.1727	0.1733
Loan loss prov. ratio	0.0100	0.0193	-0.0077	0.0040	0.0973	121	96.53	0.1133	0.0218
Market based variables									
Bank CDS spread	2.7075	2.5590	0.7068	1.6791	11.73	54	67.78	0.2703	0.4746
Bank stock return 2011-13	19.29	52.38	-92.31	17.15	147	41	48.63	0.1005	0.2584
Bank stock 4-factor alpha	0.0418	0.1609	-0.5481	0.0646	0.4818	41	48.63	0.1746	0.2606
M/B ratio	0.7870	0.4029	0.0224	0.7255	1.7939	42	48.32	0.0133	0.0173

The table reports descriptive statistics of variables used in regressions and a selection of other variables. Dependent variables are reported in percentage points. IFRS is an indicator of whether a bank reports according to IFRS or national accounting standards. Total assets are in millions of EUR. Column (7) and column (8) report R squared of univariate regressions of AQR adjustment of NPE and adjustment of provisions on explanatory variables.

The mean value of AQR adjustment of nonperforming exposures is 1.88% of risk weighted credit exposures. The variation across banks is substantial; the adjustment ranges from a reduction of -3.5% to an increase of 13.8%.[53] For 3 banks there were no changes in NPE; for 10 banks NPE were adjusted downwards during the AQR. The average adjustment of provisions for credit exposures due to the AQR is 0.84% of credit exposures, with 18 banks displaying no adjustment. For adjustment of corporate and real estate NPE and provisions the number of banks with non-missing data is lower as we set adjustments to zero if a bank does not report any exposures to the relevant sector. Univariate regressions highlight the importance of a few variables with a particularly high explanatory power. Among the variables describing macroeconomic conditions, government bond yield stands out with the highest R squared. When looking at bank characteristics ROA and impaired loans ratio exhibit relatively high univariate R squared ratio. Looking at market based measures, CDS spreads and abnormal returns on bank stocks are very strong predictors of forbearance, in particular the adjustment in provisions for credit exposures.

5.4 Results

This section presents results of regressions explaining forbearance with macroeconomic conditions, quality of banking supervision and measures of bank weakness. Table 2 displays regressions of AQR adjustment of NPE. GDP growth, government bond yields, expected default frequency (EDF) of nonfinancial firms and unemployment rate are included in three different setups in columns (1) to (3). They are not included simultaneously as they are highly correlated – they are all proxies for adverse macroeconomic conditions. The effect of government bond yields is the most significant. The higher the yield on government bonds, the more loans banks forbear and the higher the AQR adjustment of NPE. From five possible measures of quality of bank supervision, we include indices that measure stringency of capital regulation, effectiveness of private monitoring by auditing firms and credit rating agencies, and moral hazard mitigation in deposit insurance. The other two measures of banking supervision do not contribute much when combined with other explanatory variables. Consistent with hypothesis 2, negative coefficients indicate that stricter regulation leads to less forbearance. Looking at bank-level variables, larger banks tend to have lower adjustment of NPE. The level

[53] We exclude an outlier, Merrill Lynch International, Ireland. Credit exposures of Merrill Lynch represent only 7% of its RWA and their adjustment equal to 31% is an outlier compared to other banks in the sample. We also change the value of Tier 1 ratio to missing for three banks with Tier 1 capital above 50% of RWA. These are Banque Centrale de Compensation, Deutsche Bank (Malta) Ltd and Nederlandse Waterschapsbank N.V.

of Tier 1 ratio does not seem to be related to the extent of forbearance revealed by the AQR, while more profitable banks have less forborne loans.

Table 2: AQR adjustment of nonperforming exposures.

	AQR adj. NPE (1)	AQR adj. NPE (2)	AQR adj. NPE (3)	AQR adj. NPE (4)	AQR adj. NPE (5)	AQR adj. NPE (6)
GDP growth, 5 year	-3.1282			5.2448		-10.8501
	(-0.50)			(0.78)		(-1.39)
Govt. bond yield		28.3081**				
		(2.90)				
EDF nonfin. sector			8.8941			
			(0.35)			
Unemployment, 3 year av.			-6.8590			
			(-0.89)			
Capital regulatory ind.	-0.3442	-0.2783	-0.3200	-0.3520**	-0.1925	0.0279
	(-1.58)	(-1.12)	(-1.24)	(-2.21)	(-0.97)	(0.13)
Private monitoring ind.	-0.2318	-0.3432	-0.0717	-0.4656	0.0322	0.1058
	(-0.99)	(-1.45)	(-0.22)	(-1.57)	(0.09)	(0.26)
Moral hazard mitigation ind.	-0.8861***	-0.7888**	-1.5733***	-0.4473	-0.2152	0.1145
	(-3.20)	(-2.36)	(-5.81)	(-1.58)	(-0.55)	(0.14)
Size	-0.6040***	-0.4776**	-0.4465**	-0.4418**	-0.1970	-0.3229
	(-3.01)	(-2.53)	(-2.49)	(-2.84)	(-1.19)	(-1.44)
Tier 1 ratio	4.6306	2.5908	2.5111	3.2038	-0.8525	3.0903
	(0.71)	(0.45)	(0.52)	(0.51)	(-0.05)	(0.33)
ROA	-22.9323***	-26.8908***	-33.5323**	3.3328	-15.7395	-28.4450
	(-3.90)	(-3.61)	(-2.75)	(0.33)	(-0.80)	(-1.17)
Impaired loans ratio				11.6963**		
				(2.28)		
Bank CDS spread					0.3300***	
					(3.20)	
Bank stock 4-factor alpha						-2.6282
						(-0.62)
N of observations	114	104	99	104	49	41
Coverage of bank assets [%]	95.89	95.07	85.90	92.02	66.32	48.63
Adjusted R2	0.1914	0.2400	0.2469	0.2688	0.2481	0.1700

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

In column (4) to (6) we add additional measures of bank weakness as explanatory variables. The reason why we do not include them already in previous specifications is to perform baseline estimations on the largest possible sample in columns (1) to (3). Adjustment of NPE is available for 119 banks. Specification (1) includes only 5 less. Including impaired loans ratio in column (4) reduces the number of observations by 10 banks. Using CDS spread or abnormal return on bank stock further limits the sample. The accounting measure of impaired loans is positively related to AQR adjustment of NPE. More recognized impaired loans point at additional forborne exposures not reported in accounting statements but identified by the AQR. Bank CDS is a particularly strong predictor of NPE adjustment.

Abnormal stock return, however, does not appear to be informative. Adjusted R squared ratio indicates the independent variables explain about 25% of variation in adjustment of NPE. The results confirm our hypotheses 1, 2, 4a and 4b.[54] Adverse macroeconomic conditions, low quality of bank supervision and weak banks are positively related to the extent of forbearance.

Table 3: AQR adjustment of credit provisioning.

	AQR adj. credit prov. (1)	**AQR adj. credit prov. (2)**	**AQR adj. credit prov. (3)**	**AQR adj. credit prov. (4)**	**AQR adj. credit prov. (5)**	**AQR adj. credit prov. (6)**
GDP growth, 5 year	-5.9820*			-2.6855		-10.2562***
	(-1.92)			(-0.82)		(-7.12)
Govt. bond yield		29.0558***				
		(8.59)				
EDF nonfin. sector			-4.1703			
			(-0.40)			
Unemployment, 3 year av.			8.7974**			
			(2.64)			
Capital regulatory ind.	-0.4032***	-0.3053***	-0.6137***	-0.4402***	-0.3840***	-0.2013
	(-4.13)	(-6.63)	(-4.02)	(-5.22)	(-4.76)	(-1.67)
Private monitoring ind.	-0.2997**	-0.3833***	-0.5434***	-0.3703	-0.1903	-0.2565**
	(-2.80)	(-6.03)	(-4.27)	(-1.74)	(-1.69)	(-2.58)
Moral hazard mitigation ind.	-0.4960*	-0.3901***	-0.6701**	-0.4956**	-0.1458	-0.2378
	(-2.11)	(-3.52)	(-2.97)	(-2.29)	(-1.16)	(-0.81)
Size	-0.1793*	-0.0111	-0.1113	-0.1154	-0.0557	-0.0028
	(-1.95)	(-0.26)	(-0.91)	(-1.26)	(-0.51)	(-0.02)
Tier 1 ratio	-1.0129	-1.5938	-0.4126	-0.2845	-8.4129*	-2.5836
	(-0.71)	(-1.48)	(-0.41)	(-0.18)	(-2.14)	(-0.81)
ROA	-7.3845	-10.3829**	-17.0333**	2.4944	5.8207	0.4085
	(-1.19)	(-2.22)	(-2.42)	(0.39)	(1.12)	(0.05)
Impaired loans ratio				4.1037**		
				(2.21)		
Bank CDS spread					0.3310***	
					(6.07)	
Bank stock 4-factor alpha						-4.1015*
						(-2.08)
N of observations	121	108	106	105	51	41
Coverage of bank assets [%]	98.24	97.27	88.25	92.08	67.71	48.63
Adjusted R2	0.2928	0.4697	0.3481	0.3341	0.4970	0.4443

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Regressions in Table 3 explain the adjustment of provisions for credit exposures with the same set of independent variables as used in regressions in Table 2. The estimated effects on adjustment of provisions are similar to those on the adjustment of NPE, only more significant. GDP growth as well as unemployment rate are significant with expected signs. The effects of capital regulatory index and private monitoring index are more significant. The ratio

[54] We test hypothesis 3 about the importance of collateral values only on a subsample of banks with exposures to real estate loans.

of explained variance increases up to almost 0.50. It is particularly high in specification (5) with bank CDS spread. These results suggest the room for discretion in provisioning is larger than in recognition of NPE. The same factors that explain some variation in underreporting (forborne) NPE predict an even larger effect on under-provisioning. The number of observations is slightly higher as adjustment of provisions is reported also for some banks with no adjustment of NPE.

Table 4: AQR adjustment of NPE and credit provisioning by exposure type.

	AQR adj. RRE NPE (1)	AQR adj. corp. NPE (2)	AQR adj. RRE credit prov. (3)	AQR adj. SME credit prov. (4)	AQR adj. corp credit prov. (5)	AQR adj. corp. NPE * coverage (6)
GDP growth, 5 year	-0.0926	-0.8532	-4.9309	-9.0048***	-7.3505	0.0175
	(-0.01)	(-0.07)	(-1.11)	(-3.43)	(-1.35)	(0.47)
House prices, peak to trough	0.0187		0.0336			
	(0.69)		(0.53)			
Capital regulatory ind.	-0.4167***	-0.7063*	-0.3038	-0.5022*	-0.5724***	-0.0023**
	(-3.47)	(-1.88)	(-0.60)	(-2.06)	(-3.12)	(-2.33)
Private monitoring ind.	-0.0115	-0.0859	-0.7246	-0.1668	-0.3092**	-0.0005
	(-0.06)	(-0.19)	(-1.23)	(-0.73)	(-2.22)	(-0.56)
Moral hazard mitigation ind.	0.1040	-1.7709***	-0.5185	-0.3697	-0.7796*	-0.0047*
	(0.33)	(-4.11)	(-1.25)	(-0.86)	(-1.77)	(-2.01)
Size	0.0608	-0.9458***	-0.0612	-0.0415	-0.3645*	-0.0021*
	(0.49)	(-3.23)	(-0.57)	(-0.31)	(-1.90)	(-1.82)
Tier 1 ratio	4.8885	-2.9913	-0.1858	-6.0348	-1.0493	0.0072
	(1.07)	(-0.33)	(-0.04)	(-0.87)	(-0.34)	(0.42)
ROA	-15.0552*	-25.4208	3.7250	22.3618	-17.7561	-0.0876
	(-1.88)	(-0.86)	(0.19)	(1.32)	(-1.31)	(-1.17)
N of observations	75	109	99	93	119	102
Coverage of bank assets [%]	78.26	94.48	92.32	87.49	97.75	92.25
Adjusted R2	-0.0305	0.2291	0.0314	0.0073	0.2426	0.2139

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

In Table 4 we investigate the effects on adjustment of NPE and provisions separately by the type of exposures: retail real estate, SME and corporate, which on average account for 27%, 4% and 46% of bank credit exposure, respectively in risk weighted terms. Exposures to sovereigns amount to only 3% in risk weighted terms – high rated exposures to sovereigns have a zero risk weight. The remainder are exposures to institutions (13%), other retail exposures (8%) and other assets (7%). We use the set of explanatory variables as in specification (1) in the previous two tables in order to allow for the maximum number of observations. The number of observations is limited as not all banks have exposure to all types of assets. We test hypothesis 3 about the effect of a drop in collateral value in regressions of adjustment of residential real estate NPE and provisions for RRE. The effects for corporate exposures are very similar as in Table 2 and Table 3, which is reasonable given that they represent the largest share of credit exposures. The estimated coefficients for RRE and SME exposures have expected signs if

significant but the adjusted R squared in those regressions is very low. Contrary to the hypothesis 3 that banks are more likely to forbear loans when the value of collateral has dropped more, the peak to trough drop in house prices does not have a significant effect on adjustment of NPE RRE exposures.[55] The effects on additional provisioning for newly classified corporate NPE in specification (6) are very similar to the effects on provisioning for corporate exposures in general.

Table 5: Aggregate AQR adjustment.

	AQR adjustment (1)	AQR adjustment (2)	AQR adjustment (3)	AQR adjustment (4)	AQR adjustment (5)	AQR adjustment (6)
GDP growth, 5 year	-3.9319			-1.6571		-7.4299***
	(-1.47)			(-0.63)		(-5.80)
Govt. bond yield		20.6380***				
		(7.49)				
EDF nonfin. sector			-1.7939			
			(-0.19)			
Unemployment, 3 year av.			5.5243*			
			(1.93)			
Capital regulatory ind.	-0.2710***	-0.1940***	-0.3941**	-0.2757***	-0.2385***	-0.0633
	(-3.03)	(-3.78)	(-2.81)	(-3.55)	(-5.24)	(-0.55)
Private monitoring ind.	-0.1929**	-0.2615***	-0.3422***	-0.2700*	-0.0920	-0.1761*
	(-2.74)	(-7.15)	(-3.49)	(-2.02)	(-1.59)	(-1.98)
Moral hazard mitigation ind.	-0.4451**	-0.3552***	-0.5212**	-0.4146**	-0.1132*	-0.1413
	(-2.51)	(-5.48)	(-2.90)	(-2.43)	(-1.87)	(-0.59)
Size	-0.1674*	-0.0228	-0.1299	-0.1425*	-0.0179	-0.0383
	(-2.05)	(-0.62)	(-1.03)	(-1.74)	(-0.20)	(-0.45)
Tier 1 ratio	0.7954	1.0493	0.9177	0.8525	1.3217	3.4283
	(0.62)	(1.03)	(1.06)	(0.65)	(0.47)	(1.12)
ROA	-6.3263	-7.8462	-12.1708	0.0130	7.1349***	-1.7174
	(-1.20)	(-1.55)	(-1.76)	(0.00)	(3.27)	(-0.25)
Impaired loans ratio				2.6880**		
				(2.33)		
Bank CDS spread					0.2540***	
					(9.14)	
Bank stock 4-factor alpha						-3.3928**
						(-2.31)
N of observations	121	108	106	105	51	41
Coverage of bank assets [%]	98.24	97.27	88.25	92.08	67.71	48.63
Adjusted R2	0.2959	0.5255	0.3408	0.3309	0.6279	0.5825

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Finally, in Table 5 we perform estimations with aggregate AQR adjustment as dependent variable, which includes adjustments of other assets and tax effect of the adjustments. Overall, the results are similar as for the adjustment of credit provisions, which are for most banks the

[55] We run regressions (not reported) also with other proxies for real estate prices but neither of them has a significant effect.

largest component of the aggregate adjustment. The share of explained variance is higher than in other regressions, reaching up to 60%. Macroeconomic conditions, quality of bank supervision and measures of bank weakness have significant effects and are consistent with other results on forbearance.

5.5 Robustness checks

In the robustness checks we scale the adjustment of provisions for credit exposures by gross loans instead of by risk weighted credit exposure, and the aggregate adjustment by total assets. Scaling by risk weighted value of exposures is reasonable when adjustment of provisions for assets with higher risk weights are expected to be larger than on assets with lower risk weights. If risk weighting does not properly capture this, scaling by nominal amounts could be better. Table 6 in the Appendix reports results of regressions with adjustment of provisions for credit exposures scaled by gross loans. The explanatory variables are the same as in Table 2 with the only difference that we use leverage ratio (common equity over total assets) instead of Tier 1 capital ratio and include risk weighted asset ratio as an explanatory variable to capture the effect of riskier assets leading to larger provisions. The results are very similar. All significant coefficients have the same signs in both tables. Leverage ratio does not have a significant effect. The effect of RWA ratio is marginally significant in one specification. The adjusted R squared ratio is higher in all specifications, suggesting that adjustments of provisions are more informative when scaled by the nominal amount of exposures than by the risk weighed. The reason why we report the results with provisions scaled by risk weighted exposures in the main results and the non-risk weighted here in the robustness section and not vice versa is that the results for total credit exposures can then be easily compared to those for real estate, corporate and SME exposures, which we can only scaled by risk weighted amounts. The results on the aggregate adjustment scaled by total assets, reported in Table 7 in the Appendix to this chapter are similar to those on the aggregate adjustment scaled by risk weighted assets in Table 5. Adjusted R squared ratios are higher than in Table 5, with the only difference that adjusted R squared ratios are higher, reaching up to 0.70.

Most banks use IFRS. A limited number, 22 out of 130 banks, representing 8% of total banking assets, report according to national accounting standards. To check whether the harmonization of reporting by banks that use national accounting standards matters for our results we rerun the regressions on a subsample excluding the banks that do not use IFRS. Table 8 in the Appendix reports the regressions for adjustment of NPE. The results are very similar to those on the full sample in line with our presumption that different treatment of forborne

exposures was the main part of the adjustment of NPE rather than harmonization in other aspects of accounting standards. We also run regressions of the adjustment of provisions and aggregate adjustment on the subsample, but do not report them as they are almost identical to those on the full sample.

5.6 Conclusions

In this chapter we investigate what drives forbearance, the practice of offering distressed borrowers concessions that effectively delay loan repayment and allow banks to make less provisions for loan losses. We exploit the results of the AQR, a comprehensive review of asset values of 130 Eurozone banks performed in 2014, to construct measures of forbearance. In contrast to accounting standards that do not clearly define forbearance and hence do not require banks to recognize forborne exposures as nonperforming, AQR uses a precise definition of forbearance measures and applies it as an impairment trigger in the context of existing account standards. This allows us to use the AQR adjustment of NPE and the associated increase of provisions as measures of forbearance. Following the related literature, we formulate hypotheses and investigate to what extent cross-sectional variation in forbearance across banks can be explained by macroeconomic conditions, quality of bank supervision, bank balance sheet variables and market based measures.

We find that adverse macroeconomic conditions, lax bank supervision and measures of bank weakness are significantly related to the extent of forbearance. These measures explain about 25% of variation in the AQR adjustment of NPE across banks and up to 50% of variation in adjustment of provisions. In particular bank CDS spreads are a strong predictor of underprovisioning.

While our analysis provides suggestive evidence for economically plausible relationships, we cannot identify the precise channels through which the factors influence forbearance – for instance the effect of government bond yield could hint at weak macro environment in which bank borrowers are facing financial difficulties, but on the other hand it could also point at incentives of regulators and governments to allow forbearance. If government yields are excessively high, the states cannot effectively support banks that need to be recapitalized, therefore the local supervisors in such countries might have an incentive to allow banks to conceal losses and continue operating as zombie banks, as they themselves cannot save them nor allow an uncontrolled insolvency.

5.7 Appendix

5.7.1 Weighting scheme

We use data on bank exposures to 67 different countries to weight variables describing macroeconomic conditions. These data are from ECB and have a few limitations that need to be addressed. Firstly, total exposures are not always equal to total assets. However, in most cases, more than 90% of assets are covered. Secondly, data on some exposures are missing for 30 banks in the AQR sample. We scale up other exposures of these banks so that they sum up to 100% of total assets. Then we assume that the banks, for which exposure data is missing completely, are only exposed to the country they are headquartered in. Given that the covered banks have an average exposure of 73% to their home country, this is a reasonable approximation. Lastly, macroeconomic data is not available for all countries banks can have exposures to. We deal with this problem as follows: If for example government bond yield data for Luxemburg is missing, for the specific purpose of calculating the weighted government bond yield, the exposure of all banks towards Luxemburg is dropped and the remaining exposures are scaled up to sum to 100%. However, this procedure is only applied if the macroeconomic variable is available for the country the financial institution is headquartered in. If not, the macroeconomic variable is treated as missing for such a bank. This rule implies that in our particular dataset, the macroeconomic variables need to be available for at least 55% of exposures of a bank; otherwise the macroeconomic variable is reported as missing.

5.7.2 Robustness checks

Table 6: AQR adjustment of credit provisioning, scaled by gross loans.

	AQR adj. credit prov./ loans (1)	AQR adj. credit prov./ loans (2)	AQR adj. credit prov./ loans (3)	AQR adj. credit prov./ loans (4)	AQR adj. credit prov./ loans (5)	AQR adj. credit prov./ loans (6)
GDP growth, 5 year	-3.1185			0.6154		-8.5210***
	(-1.23)			(0.24)		(-7.00)
Govt. bond yield		20.2486***				
		(5.32)				
EDF nonfin. sector			-4.6522			
			(-0.55)			
Unemployment, 3 year av.			4.1819			
			(1.40)			
Capital regulatory ind.	-0.2212***	-0.1830***	-0.3868**	-0.2790***	-0.1844**	-0.1208
	(-2.93)	(-3.55)	(-3.01)	(-6.06)	(-3.04)	(-1.23)
Private monitoring ind.	-0.3321***	-0.3865***	-0.4696***	-0.4475***	-0.1757**	-0.1912**
	(-4.83)	(-4.38)	(-4.61)	(-3.45)	(-2.29)	(-2.98)
Moral hazard mitigation ind.	-0.4326**	-0.3515**	-0.6780***	-0.4407***	-0.0669	-0.1855
	(-2.63)	(-2.56)	(-3.56)	(-3.09)	(-0.72)	(-1.10)
Size	-0.1544**	-0.0675	-0.1159	-0.1106*	-0.0458	-0.1004*
	(-2.22)	(-1.30)	(-1.15)	(-1.79)	(-0.45)	(-2.15)
Common equity/ TA	-0.0186	-1.4635	2.2947	-1.8449	3.6899	-5.7053
	(-0.01)	(-0.72)	(1.10)	(-0.74)	(0.78)	(-0.89)
RWA/ TA	1.2324*	0.3754	0.2720	0.7471	-0.3714	-0.9465
	(1.75)	(0.82)	(0.50)	(1.16)	(-0.86)	(-0.88)
ROA	-5.1317	-7.2860*	-11.4712*	5.9412	2.5784	1.0120
	(-1.12)	(-1.84)	(-2.12)	(1.39)	(0.44)	(0.21)
Impaired loans ratio				5.0457***		
				(3.97)		
Bank CDS spread					0.2379***	
					(7.29)	
Bank stock 4-factor alpha						-3.8854***
						(-4.00)
N of observations	119	108	103	105	50	41
Coverage of bank assets [%]	98.14	97.36	87.82	92.08	67.66	48.63
Adjusted R2	0.3651	0.4999	0.3709	0.4624	0.5653	0.6710

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 7: Aggregate AQR adjustment, scaled by total assets.

	AQR adjustment / TA (1)	AQR adjustment / TA (2)	AQR adjustment / TA (3)	AQR adjustment / TA (4)	AQR adjustment / TA (5)	AQR adjustment / TA (6)
GDP growth, 5 year	-1.5635			-0.4851		-5.2032***
	(-0.79)			(-0.24)		(-7.17)
Govt. bond yield		12.9428***				
		(6.95)				
EDF nonfin. sector			-3.2724			
			(-0.56)			
Unemployment, 3 year av.			3.3893			
			(1.71)			
Capital regulatory ind.	-0.1348**	-0.0952***	-0.2368**	-0.1545***	-0.1105***	-0.0225
	(-2.41)	(-3.15)	(-2.54)	(-3.05)	(-4.14)	(-0.28)
Private monitoring ind.	-0.1260**	-0.1626***	-0.2267***	-0.1618	-0.0846***	-0.1056*
	(-2.19)	(-5.63)	(-3.08)	(-1.70)	(-3.02)	(-2.02)
Moral hazard mitigation ind.	-0.2448**	-0.1546***	-0.3163**	-0.2765**	-0.0677**	-0.0596
	(-2.13)	(-3.36)	(-2.32)	(-2.14)	(-2.20)	(-0.56)
Size	-0.1051**	-0.0331	-0.1084	-0.1001*	-0.0109	-0.0645
	(-2.25)	(-1.39)	(-1.18)	(-1.95)	(-0.22)	(-1.69)
Common equity/ TA	1.0089	-0.5601	2.6620	0.6129	3.7195**	-1.8189
	(0.54)	(-0.74)	(1.48)	(0.32)	(2.18)	(-0.36)
RWA/ TA	0.7599	0.1361	0.1251	0.6072	-0.1751	-0.3838
	(1.74)	(0.82)	(0.41)	(1.19)	(-0.62)	(-0.46)
ROA	-3.2444	-4.5778	-6.5652	-0.1983	3.7337*	-0.6523
	(-0.98)	(-1.41)	(-1.57)	(-0.05)	(2.06)	(-0.23)
Impaired loans ratio				1.3410		
				(1.71)		
Bank CDS spread					0.1473***	
					(8.10)	
Bank stock 4-factor alpha						-2.3974***
						(-3.41)
N of observations	123	110	107	105	51	41
Coverage of bank assets [%]	99.65	98.69	89.33	92.08	67.71	48.63
Adjusted R2	0.3246	0.6119	0.3503	0.3248	0.6996	0.6684

Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 8: AQR adjustment of NPE, only banks that report according to IFRS.

	AQR adj. NPE/ loans (1)	AQR adj. NPE/ loans (2)	AQR adj. NPE/ loans (3)	AQR adj. NPE/ loans (4)	AQR adj. NPE/ loans (5)	AQR adj. NPE/ loans (6)
GDP growth, 5 year	-0.5722			13.5949*		-8.5825
	(-0.08)			(1.90)		(-1.39)
Govt. bond yield		21.8423				
		(1.49)				
EDF nonfin. sector			6.6009			
			(0.23)			
Unemployment, 3 year av.			-12.5315			
			(-1.05)			
Capital regulatory ind.	-0.1679	-0.1713	-0.0589	-0.3431*	-0.0826	-0.1511
	(-0.55)	(-0.52)	(-0.16)	(-1.84)	(-0.59)	(-0.88)
Private monitoring ind.	-0.5958	-0.6591	-0.3473	-0.9643**	-0.0188	0.1886
	(-1.42)	(-1.42)	(-0.69)	(-2.47)	(-0.08)	(0.50)
Moral hazard mitigation ind.	-1.1178**	-1.1959*	-1.9321***	-0.9099***	-0.2424	-0.3007
	(-2.50)	(-2.03)	(-3.45)	(-2.94)	(-0.78)	(-0.52)
Size	-0.7863**	-0.7357*	-0.5791	-0.3931*	-0.2379*	-0.3473
	(-2.34)	(-1.91)	(-1.72)	(-1.85)	(-1.88)	(-1.46)
Tier 1 ratio	-1.5977	3.8105	-3.0177	-0.9471	3.2575	13.6860
	(-0.26)	(0.53)	(-0.48)	(-0.15)	(0.33)	(1.62)
ROA	-15.0930	-16.9119	-24.5000	29.3009	-19.3026	-21.3377
	(-1.44)	(-1.11)	(-1.23)	(1.09)	(-1.09)	(-1.01)
Impaired loans ratio				19.4916**		
				(2.23)		
Bank CDS spread					0.2682**	
					(3.05)	
Bank stock 4-factor alpha						-2.2085
						(-0.64)
N of observations	92	83	81	89	45	38
Coverage of bank assets [%]	81.79	81.12	74.01	80.61	59.00	42.23
Adjusted R2	0.1777	0.2095	0.2157	0.3577	0.3265	0.2031

Banks that use national accounting standard are not included in this sample. Regressions are estimated with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Chapter 6
Making Sense of Measures of Bank Vulnerability: ECB/EBA stress test vs. SRISK

6.1 Introduction

When the results of the ECB Comprehensive Assessment (CA) were published, the exercise was proclaimed a success by policy makers. At the same time, in a series of policy papers Acharya and Steffen (2014a,b,c) use SRISK as a benchmark for the stress test to cast doubt on its robustness. They point at the negative correlation between ECB/EBA stress test shortfalls and SRISK, questioning whether the CA has properly taken into account systemic risk (Steffen 2014) and suggesting that the use of risk weighted assets and discretion of national regulators could have affected the results of the ECB/EBA stress test (Acharya and Steffen 2014b). The stark differences between the two measures raise questions about how much can different approaches for assessing bank vulnerability be trusted. What risks do they capture and which they ignore? How much can we rely on their outcomes? In this chapter we compare the two measures by explaining their variation across banks with various factors expected to predict bank vulnerability. The analysis reveals their conceptual differences and the scale of discrepancies in the expected losses in the stress scenario.

The way stress test impact on bank capital is constructed differs fundamentally between the ECB/EBA stress test and SRISK. While the former starts by specifying a macro scenario and possible shocks to the financial markets, and then derives key metrics such as probability of default and loss given default for loans via a model, SRISK infers the stress impact from long term covariance of bank stock returns with market returns, specifying the initial shock in terms of a decline in the stock market. It thereby sidesteps modelling the transmission mechanisms of

macroeconomic developments to bank risk metrics and then to bank losses explicitly and rather models directly banks losses.

Proponents of the market based perspective would argue that while not modelling the transmission channels and a sophisticated stress scenario, assuming that a severe downturn at the stock market is a reflection of a severe crisis, the information contained in the thus modelled bank losses implicitly accounts for all the relevant transmission channels. This can be argued to bear fewer sources of mistakes or omissions, as the market processes the entire information set. In particular, complex contagion mechanisms that are notoriously difficult to model, such as illiquidity spirals, fire sale externalities and information contagion, are all implicitly reflected in market prices, to the extent that the market is aware of these channels. Its conceptual problems lie within the assumptions that the model for the long term co-variation between bank returns and market returns remains valid for a long horizon and during significant stress on the banking system, which need not be the case when the market's information set changes.

While the success of a stress test, as discussed in Borio, Drehmann, and Tsatsaronis (2014), depends on the function it was designed for, the quality of a macro stress test hinges on the plausibility and severity of the scenario and its translation into stress test impact (Alfaro and Drehmann 2009). Ideally, the stress test impact should reflect banks' exposure to a number of risks, most importantly credit risk due to macro and micro factors and trading risks related to market exposures. This motivates an investigation of the stress impacts of both the ECB comprehensive assessment and SRISK to examine how they relate to a set of factors that explain bank fragility. While the previous comparisons of SRISK and ECB/EBA stress test results cited here compare the shortfalls directly, we focus on the impact of the stress scenarios employed by the ECB and by Acharya and Steffen (2014a,b) instead of the capital shortfalls. We normalise the dollar amount of stress impact by a common notion of firm exposure. The thus obtained measures capture the losses associated with the stress scenario as a fraction of exposure, which effectively defines the stress test; the shortfalls follow mechanically after defining the hurdle rate and the particular measure of leverage.

We proceed by regressing the stress impacts of both measures on a set of macro variables, bank balance sheet variables and market based measures to understand the drivers behind the stress scenarios. We regard this exercise as an anatomy lesson of the stress test measures, which should facilitate an assessment of their plausibility and their relationship to economic reality.

In Section 6.2 we provide some background about the ECB/EBA stress test and SRISK. Section 6.3 describes the data. Results about the ECB/EBA stress test are in Section 6.4. Section

6.5 compares SRISK to ECB/EBA stress test outcomes. Robustness checks are discussed in Section 6.6. Section 6.7 concludes.

6.2 Measures of bank vulnerability

6.2.1 ECB/EBA 2014 stress test

The ECB/EBA stress test was conducted on 130 Eurozone banks as a part of the comprehensive assessment (CA) in 2014. A distinguishing feature of this stress test, compared to the previous ones, is that it incorporates corrections to asset valuation and classifications that resulted from the asset quality review (AQR), which was also part of the CA. The stress test itself combined a bottom-up stress test with a top-down verification thereby achieving harmonization across participating banks and verifying the results that were subject to each bank's discretion. The baseline scenario was constructed based on European Commission forecasts for the years 2014 – 2016. The European Systemic Risk Board modified the baseline scenario by the materialization of the main risks to financial stability to arrive at the adverse scenario.[56] EBA then published the stress test methodology where key stress parameters were derived from the scenarios and restrictions were imposed on the banks' application of the scenario. The thus obtained results were cross-checked with the outcome of a macro stress test to detect misuse of banks' discretion. The main outcome of the stress test is the capital shortfall, defined as the maximum of the capital needs to meet a common equity Tier 1 (CET1) ratio of 8% in the baseline scenario or a CET1 ratio of 5.5% in the adverse scenario, where CET1 is measured according to the respective legislation in each year. The results are published in the Aggregate Report on the Comprehensive Assessment (ECB 2014a). Rather than on the shortfall, we focus on the stress impact, i.e. the loss of bank capital in the stress scenario. The shortfall shows which banks are most undercapitalized, while the stress impact is more informative about bank exposure to risks.

6.2.2 SRISK

SRISK has been proposed as a measure of systemic risk by Acharya, Engle, and Richardson (2012). SRISK of a bank is the expected capital shortfall in a severe stress scenario to a benchmark capital ratio defined in terms of market leverage. For European banks the threshold is 5.5% market leverage ratio[57]. The stress scenario is a shock that would result in a

[56] For details see EBA/SSM stress test: The macroeconomic adverse scenario (ESRB 2014).
[57] Market leverage ratio is defined as market value of equity divided by market value of assets, which is approximated as the sum of market value of equity and book value of liabilities.

40% drop in the general stock market index over a period of six months More precisely SRISK is defined as:

$$SRISK_{it} = E_t(CS_{i,t+h} \mid R_{m\,t+1:t+h} < C) \tag{1}$$

where *CS* denotes Capital shortfall and R_m indicates the systemic event as a drop in the market below the threshold *C*. This is shown by the authors to result in the following expression:

$$SRISK_{it} = k\,Debt_{it} - (1-k)\,Equity_{it}\,(1 + LRMES_{it}) \tag{2}$$

where k denotes the capital requirement. *LRMES* stands for long run marginal expected shortfall and is extrapolated from the mean daily marginal expected shortfall (*MES*) to a six month horizon via simulations. *LRMES*Equity* can be interpreted as the stress impact in euros. Normalizing it by total assets yields the SRISK stress impact:

$$\frac{SRISK_{Stress\ Impact}}{TA_{Book}} = LRMES * \frac{Equity_{Market}}{TA_{Market}} * \frac{TA_{Market}}{TA_{Book}} \tag{3}$$

There are two ways of obtaining this the stress impact from the data provided on the webpage of V-Lab. Acharya, Engle and Richardson (2012) mention an approximation to *LRMES*: $LRMES = 1 - \exp(-18 \times MES)$, which they employ in cases where simulations have not yet been implemented. Alternatively, using the SRISK measure as a starting point, we can back out the impact of the stress test on market equity as follows:

$$\frac{SRISK_{Stress\ Imapct}}{TA_{Book}} = \left(\frac{Equity_{Market}}{TA_{Market}} - 0.055\right)\left(\frac{TA_{Market}}{TA_{Book}}\right) + \frac{SRISK_{Shortfall}}{TA_{Book}} \tag{4}$$

where $Equity_{Market}$ stands for market value of equity, TA_{Market} for market value of total assets (the sum of market value of equity and book value of liabilities). $SRISK_{Shortfall}$ is the capital shortfall in EUR, which has a positive value when a bank has too little equity and negative when it has a surplus. The first expression is the difference between the initial market leverage ratio and the benchmark leverage ratio, rescaled from market value of total assets to book value of total assets. Then the shortfall after the shock is added. If a bank has an initial market leverage ratio above 5.5% and has a shortfall after the shock, the stress impact is the loss of capital from the initial level to the benchmark capital ratio plus the shortfall. If a bank is below the benchmark market leverage ratio before the shock, the stress impact is equal to the shortfall after the shock reduced for the initial shortfall. Cross-checking results obtained from these methods confirms that any disagreement due the approximation involved or different data used is insignificant, so we go ahead with the values obtained via the second method, described by equation (4).

6.3 Data and descriptive statistics

We obtain data about the ECB/EBA stress test results from the Aggregate Report on The Comprehensive Assessment (ECB 2014a) and data on banking and trading book losses from EBA. We use the following stress test outcomes as dependent variables in the regression analysis:

- **Adverse scenario stress impact / TA**: Impact of the adverse scenario of the ECB/EBA stress test on CET1 (ECB communication variable B6), scaled by total assets. Stress impact is originally reported in basis points of risk weighted assets (RWA). We rescale it and express it in percent of total assets. Normalizing the stress impact by some measure of bank size is necessary to make it comparable across banks. If one could argue that the stress impact on an asset class should be proportional to its risk weighted assets, expressing it relative to RWA would be preferable. We perform regressions with stress impact scaled by RWA as a robustness check.
- **Baseline scenario stress impact / TA**: Impact of the baseline scenario of the ECB/EBA stress test on CET1 (ECB communication variable B4), scaled by total assets. We focus on the adverse scenario stress impact, which has greater variation in outcomes across banks, and analyze the impact of the baseline scenario in robustness checks.
- **Banking book losses / TA**: Three year cumulative losses on financial and non-financial assets in the banking book in the adverse scenario, scaled by total assets. By isolating the losses on the credit portfolio from the trading activities, one would expect to see more clearly the influences of the macroeconomic stress scenario that ultimately translates into probability of default and loss given default metrics of loan portfolios.
- **Trading book losses / securities holdings**: Three year cumulative losses in the trading book in the adverse scenario, scaled by total assets.

We compute the **SRISK stress impact / TA** using equation (4) from SRISK values published on the V-Lab website.[58] By transforming the dollar values of SRISK shortfall, as they are originally reported, into stress impact scaled by total assets we make it directly comparable to the ECB/EBA stress impact.

Losses in a stress scenario are likely to depend on the existing **macroeconomic conditions**. For some variables we construct values weighted by exposure of banks to different countries to

[58] http://vlab.stern.nyu.edu/en/#

account for the fact that banks are likely to be affected by macroeconomic conditions not only in the country of their headquarters but also in countries where they have asset exposure – i.e. the effect of macroeconomic conditions in a particular country on a bank is assumed to be proportional to the exposure of the bank to that country relative to the total assets of the bank.[59] In the regression analysis we use the following variables:

- Real GDP growth, 3 year cumulated and weighted by bank exposures (Source: IMF World Economic Outlook).
- Sovereign bond yields, average of monthly observations for 2013 (Source: Bloomberg).
- Unemployment rate, 3 year average (Source: Eurostat, obtained through ECB SDW).
- Expected default frequency (EDF) for nonfinancial firms, country benchmark, average over firms weighted by total assets, average of monthly observations for 2013, weighted by bank exposures (ECB SDW[60], source: KMV – Moody's).

We use **quality of banking supervision** measures from Barth, Caprio, and Levine (2012). Variables are constructed as averages over up to four survey waves ranging back until 1999. Higher index levels imply tighter regulation.

- The bank activities restrictions index describes how much activities of banks are restricted to providing core banking services. The index is higher when banks are for example prohibited from engaging in securities underwriting, brokering or dealing, insurance underwriting, real estate investment or if banks are not allowed to own nonfinancial firms.
- The capital regulatory index is higher the more stringent regulatory requirements for holding capital are. It also measures how narrowly capital is defined.
- The supervisory power index measures whether supervisory authorities have the power to prevent and correct problems. For example, the index is higher if authorities can restructure and reorganize troubled banks or declare a deeply troubled bank insolvent.
- The private monitoring index is high when financial statements issued by a bank have to be audited, when a large share of the 10 largest banks is rated by international rating agencies, when there is no explicit deposit insurance scheme and if bank accounting fulfils certain requirements.
- The moral hazard mitigation index is based on Demirguc-Kunt and Detragiache (2002), who use principal components analysis on quantified features of explicit deposit

[59] For details about weighting macroeconomic variables by bank exposures see Appendix.
[60] ECB Statistical Data Warehouse

insurance systems. These features include: foreign currency deposits covered, interbank deposits covered, type of funding, source of funding, management, membership and the level of explicit coverage.

Bank balance sheet variables are combined from three sources. If available, we use variables from the dataset accompanying the report about the Comprehensive Assessment (ECB 2014a). Additional variables are from SNL and BankScope. For some banks SNL and BankScope are used simultaneously when total assets in both datasets do not differ by more than 10%.

- Bank size, measured as the logarithm of total assets (CA report)
- Tier 1 ratio (Source: CA report)
- Book leverage ratio: book value of equity divided by total assets (Source: CA report)
- RWA to total assets ratio (CA report)
- Gross loans (Source: SNL, BankScope)
- Securities holdings (Source: SNL, BankScope)
- ROA (Return on average assets) (Source: SNL, BankScope)
- Impaired loans ratio: impaired loans over gross loans (Source: SNL, BankScope)

Market data comes from Bloomberg unless specified otherwise:

- Bank 5 year CDS spreads, average over end-of-month observations in 2013
- Price to book ratio, end of 2013
- Market leverage ratio: market value of equity over the sum of market value of equity and book value of liabilities (source V-Lab)
- Bank stock returns for the period 2011-2013.[61]
- Bank stock 4-factor alpha: average daily abnormal return over the period 2011-2013, computed as the intercept from the Carhart (1997) four factor asset pricing model, which builds on the Fama-French (1993) three factor model and augments it with another factor capturing the momentum effect. We use the return on Eurstoxx50 as a proxy for market return and the German 5-year government bond yield as the risk free rate. The other three factors are taken from Andrea Frazzini's data library[62].

[61] For variables based on stock returns, only stocks are considered that have zero returns on less than 50% of the trading days. Stocks that have zero returns on more days may have been suspended from trading or are highly illiquid and thus not suitable for analysis.

[62] Available at https://www.aqr.com/library/data-sets/the-devil-in-hmls-details-factors-daily (Asness and Frazzini 2013)

Table 1: Descriptive statistics

Variable	Mean	St. dev.	Min	Median	Max	N	Coverage of bank assets [%]	R2: Adv. scen. stress impact	R2: SRISK stress impact
Dependent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Adv. scen. stress impact/ TA	1.9206	3.6400	-0.6768	1.2141	39.89	130	100.00		
Base. scen. stress impact/ TA	0.1668	0.5537	-0.6823	0.0375	2.8770	130	100.00		
Banking book losses	1.6771	1.5073	0.0048	1.0457	7.4541	99	87.98		
Trading book losses	0.0681	0.0756	0.0000	0.0493	0.3738	97	87.17		
SRISK stress impact/ TA	2.5258	3.1813	0.0097	1.8580	21.13	43	62.07		
SRISK stress impact/ MCAP	41.33	10.94	10.15	44.35	56.79	43	62.07		
Macroeconomic variables									
GDP growth, 3 year	0.0160	0.0534	-0.1585	0.0263	0.1535	129	99.99	0.1710	0.0006
Govt. bond yield	0.0220	0.0199	0.0063	0.0116	0.0990	111	98.89	0.2592	0.0095
EDF nonfin. sector	0.0114	0.0188	0.0016	0.0064	0.1088	117	99.52	0.0591	0.0001
Unemployment, 3 year average	0.1123	0.0567	0.0481	0.0975	0.2411	121	90.02	0.0011	0.0227
Quality of bank supervision									
Bank activity restr. ind.	5.7264	1.1502	4.5000	5.2500	7.7500	127	99.93	0.0605	0.0291
Capital regulatory ind.	6.5787	1.0428	4.8500	6.7500	8.7500	127	99.93	0.0059	0.0008
Supervisory power ind.	9.9372	1.6327	7.0000	9.5000	13.50	127	99.93	0.0481	0.0041
Private monitoring ind.	7.7992	0.7203	6.5000	7.5000	10.00	127	99.93	0.0155	0.2174
Moral hzd. mitigation ind.	1.7241	0.6427	0.5000	2.0000	2.7500	127	99.93	0.0000	0.0045
Bank balance sheet variables									
Total assets	169	303	0.5670	54.18	1,640	130	100.00	0.0134	0.0057
Tier 1 ratio	0.1367	0.0561	-0.0370	0.1225	0.3728	127	98.57	0.0127	0.0963
Book leverage ratio	0.0648	0.0721	0.0000	0.0522	0.7870	130	100.00	0.6941	0.0471
ROA	-0.0026	0.0190	-0.0788	0.0017	0.0264	126	99.73	0.3005	0.0024
ROE	-0.0818	0.4285	-2.3920	0.0302	0.3189	126	99.73	0.2472	0.0149
Loans/ TA	0.5471	0.2014	0.0201	0.5862	0.8923	124	98.40	0.0150	0.0000
Gross loans/ TA	0.5866	0.2088	0.0215	0.6326	0.9691	122	98.21	0.0439	0.0067
Securities/ TA	0.2587	0.1588	0.0034	0.2449	0.9528	120	97.33	0.0252	0.0085
RWA/ TA	0.4529	0.1995	0.0014	0.4502	1.0991	130	100.00	0.0065	0.0014
Impaired loans ratio	0.1078	0.1069	0.0000	0.0741	0.4081	108	92.15	0.4333	0.0661
Loan loss prov. ratio	0.01	0.0193	-0.0077	0.004	0.0973	121	96.53	0.1886	0.0253
Market based variables									
Bank CDS spread	2.7075	2.5590	0.7068	1.6791	11.73	54	67.78	0.4404	0.0220
Bank stock return 2011-13	19.29	52.38	-92.31	17.15	147	41	48.63	0.2545	0.1691
Bank stock 4-factor alpha	0.0418	0.1609	-0.5481	0.0646	0.4818	41	48.63	0.3057	0.0013
Market lev. ratio	5.4468	5.5243	0.0201	4.0568	35.97	43	62.07	0.0029	0.8923
P/B ratio	0.7870	0.4029	0.0224	0.7255	1.7939	42	48.32	0.0747	0.4875

The table reports descriptive statistics of variables used in regressions and a selection of other variables. Column (8) and (9) report R squared ratio of univariate regressions of ECB/EBA adverse scenario stress impact and the SRISK stress impact, respectively.

The sample of banks subject to the AQR and the stress test consists of 130 banks, but we remove four banks[63] where we have no observations on the explanatory variables in the most basic setup. The descriptive statistics of the full sample are displayed in Table 1. Most explanatory variables are available for at least 120 banks, which represent 96% or more of total assets of banks that were analyzed in the CA. For variables based on market data the coverage is more limited and includes about 40 banks, which account for 50% to 67% of total banking

[63] Deutsche Bank (Malta), AB SEB Bankas Latvia, AB DNB Bankas Latvia and Swedbank AB, Latvia, jointly representing 0.01% of sample assets.

assets. SRISK is available for a sample covering 62% of the assets of banks examined in the ECB/EBA stress test.

To provide some indication of the explanatory power of the variables later used in regressions, Table also reports R squared of univariate regressions where adverse scenario stress impact of the ECB/EBA stress test and SRISK stress impact are dependent variables and explanatory variables are included into those regressions individually. Note that the average impact of the adverse scenario normalized by total assets is 1.9 percentage points, while the SRISK stress impact is 2.5 percentage points and can thus be considered the tougher scenario, in particular because it relates to a shorter time horizon of 6 months compared to 3 years. Since SRISK threshold of sufficient capitalization is effectively higher – it is set to 5.5% market leverage ratio vs. 5.5% risk-weighted capital ratio in ECB/EBA stress test – this amplifies the difference in resulting shortfalls. For the ECB/EBA stress impact in the adverse scenario, the macroeconomic variables display high univariate explanatory power. Impaired loans ratio, ROA as well as bank CDS spreads and abnormal stock returns are highly informative (R squared from 0.30 to 0.44). For SRISK, market leverage ratio and the price to book ratio stand out with extremely high values of R squared.

6.4 Analysis of the ECB/EBA adverse scenario stress impact

The results presented in this section identify several factors that predict bank vulnerability, as measured by the ECB/EBA adverse scenario stress impact on Tier 1 capital. Table 2 displays the results for the total adverse scenario stress impact. The following two tables (Table 3 and Table 4) provide results separately for banking book losses and trading book losses. Columns (1) to (4) in Table 2 report results for regressions with variables describing macroeconomic conditions, quality of bank supervision and bank balance sheet variables. Market based measures, which are available only for a subsample of banks, are included in specifications (5) and (6). GDP growth and government bond yields have a significant effect on the stress impact in the adverse scenario. They are not included simultaneously because of their high correlation. Creditworthiness of nonfinancial corporations, measured by the average expected default frequency (EDF) and unemployment rate does have a significant effect. Restrictions on bank activities and more stringent capital requirements are associated with lower stress impact. Looking at characteristics of individual banks, smaller banks are expected to be hit more. Banks with riskier assets reflected in higher RWA ratio and high existing impaired loans are expected to suffer larger losses in the adverse scenario. Market based measures, CDS spreads and abnormal returns on bank stock are very good predictors of stress impact.

Table 2: Adverse scenario stress impact.

	Adv. scen. stress impact/ TA (1)	Adv. scen. stress impact/ TA (2)	Adv. scen. stress impact/ TA (3)	Adv. scen. stress impact/ TA (4)	Adv. scen. stress impact/ TA (5)	Adv. scen. stress impact/ TA (6)
GDP growth, 3 year	-0.4118***			-0.2739***		-0.6309***
	(-3.47)			(-3.02)		(-5.32)
Govt. bond yield		0.4700***				
		(5.37)				
EDF nonfin. sector			0.1479			
			(0.73)			
Unemployment, 3 year average			0.1893			
			(0.78)			
Bank activity restr. ind.	-0.3062**	-0.3372**	-0.2452	-0.3546***	-0.2326*	-0.3045*
	(-2.31)	(-2.43)	(-1.12)	(-4.03)	(-2.02)	(-2.17)
Capital regulatory ind.	-0.2754*	-0.3176**	-0.3385	-0.3972***	-0.1970*	-0.2580*
	(-2.07)	(-2.55)	(-1.31)	(-3.75)	(-2.08)	(-1.89)
Size	-0.2738***	-0.2232*	-0.2441**	-0.2477***	-0.2592**	-0.2340*
	(-3.21)	(-1.88)	(-2.54)	(-3.25)	(-2.42)	(-2.00)
Book leverage ratio	-0.0933	-0.1453	-0.2119*	-0.1124	-0.1552	-0.1105
	(-0.99)	(-1.59)	(-1.88)	(-1.32)	(-0.83)	(-0.67)
Loans/ TA	-0.1685*	-0.1208	-0.1698	-0.1488*	-0.1992*	-0.1296
	(-2.01)	(-1.28)	(-1.50)	(-1.77)	(-2.07)	(-1.05)
RWA/ TA	0.3855***	0.3034***	0.3873***	0.2312**	0.3440*	-0.0028
	(4.10)	(3.38)	(3.57)	(2.57)	(2.12)	(-0.02)
ROA	-0.3694**	-0.4141***	-0.4846***	-0.2045	-0.2302	-0.1400
	(-2.77)	(-3.90)	(-4.60)	(-1.37)	(-1.40)	(-0.91)
Impaired loans ratio				0.4084***		
				(4.51)		
Bank CDS spread					0.6559***	
					(7.12)	
Bank stock 4-factor alpha						-0.3768*
						(-1.89)
N of observations	121	108	105	105	51	41
Coverage of bank assets [%]	98.33	97.36	88.01	92.08	67.71	48.63
Adjusted R2	0.5082	0.5653	0.4350	0.6005	0.5965	0.5796

The dependent variable is adverse scenario stress impact scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 3 displays the results for banking book losses under the adverse scenario. The explanatory variables and the structure of the table are identical as in Table 2 for the total impact of the adverse scenario. Overall, the results are similar with some noteworthy differences. The positive effect of EDF of nonfinancial firms is now significant. Bank activity restriction and capital regulatory index become less informative. For restrictions on bank activities this is expected as they mainly apply to activities that are part of the trading book not banking book. In contrast to the total stress impact, bank size does not matter much for banking book losses. Impaired loans ratio, CDS spread and abnormal bank stock returns remain strong predictors. The share of explained variance is higher than in regressions of total stress impact, reaching up to 70%.

Table 3: Banking book losses.

	Banking book losses/ TA (1)	Banking book losses/ TA (2)	Banking book losses/ TA (3)	Banking book losses/ TA (4)	Banking book losses/ TA (5)	Banking book losses/ TA (6)
GDP growth, 3 year	-0.3593***			-0.1456*		-0.4413***
	(-4.93)			(-2.04)		(-6.25)
Govt. bond yield		0.4649***				
		(10.65)				
EDF nonfin. sector			0.4125***			
			(5.73)			
Unemployment, 3 year average			0.1773			
			(1.20)			
Bank activity restr. ind.	0.0958	0.0942	0.1144	0.1600**	0.3049	-0.0198
	(0.97)	(0.98)	(0.80)	(2.68)	(1.49)	(-0.11)
Capital regulatory ind.	-0.0405	-0.0932	-0.1523	-0.1044*	-0.1475	-0.1375
	(-0.56)	(-1.43)	(-0.89)	(-2.01)	(-1.10)	(-1.12)
Size	-0.0667	-0.0117	0.0174	0.0016	0.1688	-0.0275
	(-1.03)	(-0.18)	(0.26)	(0.03)	(1.39)	(-0.22)
Book leverage ratio	-0.1684	-0.1546	-0.2065*	-0.1635**	0.1985	-0.1275
	(-1.72)	(-1.75)	(-2.13)	(-2.20)	(0.91)	(-1.00)
Loans/ TA	-0.0135	0.0761	0.1157	0.1121	0.1566	0.1431
	(-0.23)	(1.48)	(1.66)	(1.31)	(1.11)	(0.98)
RWA/ TA	0.5737***	0.4778***	0.4678***	0.4265***	0.0756	0.2026
	(4.57)	(3.89)	(3.42)	(3.81)	(0.30)	(0.86)
ROA	-0.1334*	-0.0657	-0.0175	0.0150	0.2736***	-0.0104
	(-1.81)	(-0.76)	(-0.22)	(0.16)	(3.70)	(-0.06)
Impaired loans ratio				0.3975***		
				(4.25)		
Bank CDS spread					0.4959***	
					(6.41)	
Bank stock 4-factor alpha						-0.3959**
						(-2.92)
N of observations	99	93	87	89	43	39
Coverage of bank assets [%]	87.98	87.37	77.93	83.67	63.50	48.56
Adjusted R2	0.6642	0.6912	0.6936	0.6893	0.7278	0.6353

The dependent variable is banking book losses under the adverse scenario scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 4 presents the results for trading book losses under the adverse stress scenario. Relatively low R squared compared to regressions of total stress impact, suggests that expected trading losses do not depend much on existing macroeconomic conditions or past idiosyncratic performance of banks. The most significant are the effects of bank size, leverage and the ratio of loans to total assets. Banks with a larger loan portfolio, almost by definition, have lower trading loses. Impaired loans ratio, bank CDS and abnormal return are not informative at all.[64] Overall, our results are in line with research linking credit losses to macroeconomic dynamics, as for instance Pesaran et al. (2003), Mileris (2012) and Kearns (2004). It is intuitive that the

[64] In an unreported robustness test, we check whether the reason for poor prediction of trading losses is scaling by total assets. As a better proxy for the size of trading book, we use bank securities holdings. The estimates, however, do not improve in terms of statistical significance.

regressions explaining the banking book losses exhibit higher explanatory power than the regressions explaining the trading losses, as net trading positions are far more heterogeneous across banks in a country than loan portfolio compositions, and also bear less systematic relation to balance sheet information apart from the size of the trading book, which is strictly negatively related to the loans over total assets ratio.

Table 4: Trading book losses.

	Trading book losses/ TA (1)	**Trading book losses/ TA (2)**	**Trading book losses/ TA (3)**	**Trading book losses/ TA (4)**	**Trading book losses/ TA (5)**	**Trading book losses/ TA (6)**
GDP growth, 3 year	0.0701			0.0586		-0.0886*
	(0.48)			(0.42)		(-2.14)
Govt. bond yield		0.1014				
		(1.10)				
EDF nonfin. sector			0.1572			
			(1.42)			
Unemployment, 3 year average			-0.2465*			
			(-1.88)			
Bank activity restr. ind.	0.0501	-0.1035	0.0472	-0.0314	-0.1096	0.2369**
	(0.31)	(-0.63)	(0.30)	(-0.20)	(-0.48)	(2.52)
Capital regulatory ind.	-0.1414	-0.2140*	-0.0001	-0.1879	-0.3380**	-0.1112
	(-1.53)	(-2.13)	(-0.00)	(-1.64)	(-2.27)	(-1.41)
Size	0.2507***	0.2495***	0.3319***	0.2208**	-0.0351	0.2907*
	(3.00)	(3.32)	(3.16)	(2.88)	(-0.18)	(2.18)
Book leverage ratio	-0.2110***	-0.2212***	-0.2255***	-0.2325***	-0.0243	-0.2006*
	(-3.34)	(-3.31)	(-3.20)	(-3.05)	(-0.15)	(-1.80)
Loans/ TA	-0.3418***	-0.3443***	-0.1875	-0.2960**	-0.3216*	-0.5011**
	(-3.35)	(-3.59)	(-1.38)	(-2.85)	(-2.03)	(-2.71)
RWA/ TA	0.2089	0.1878	0.1264	0.1682	0.0345	0.4433***
	(1.60)	(1.30)	(0.78)	(1.06)	(0.15)	(6.93)
ROA	-0.0110	-0.0175	0.0365	-0.0243	0.0755	0.3651***
	(-0.12)	(-0.18)	(0.30)	(-0.26)	(0.59)	(4.24)
Impaired loans ratio				-0.0056		
				(-0.04)		
Bank CDS spread					-0.0637	
					(-0.43)	
Bank stock 4-factor alpha						0.0037
						(0.02)
N of observations	99	93	87	89	43	39
Coverage of bank assets [%]	87.98	87.37	77.93	83.67	63.50	48.56
Adjusted R2	0.1868	0.1848	0.1829	0.1474	0.0243	0.2244

The dependent variable is trading book losses under the adverse scenario scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

6.5 Comparing the ECB/EBA stress test outcomes with SRISK

Acharya and Steffen (2014c) find SRISK[65] to be negatively correlated to the shortfall of banks in the adverse scenario of the ECB/EBA stress test but positively correlated with the banking book and trading book losses in the adverse scenario of the same stress test. The stress scenarios of the two measures are different and the benchmark capital requirements differ (5.5% market leverage ratio in SRISK and 5.5% CET 1 ratio in the ECB/EBA stress test). Hence it is not surprising that the two shortfalls are not highly correlated. Figure 1 displays the negative correlation between the nominal values of shortfalls (left) and the correlation between the stress impacts scaled by total assets, which is close to zero.

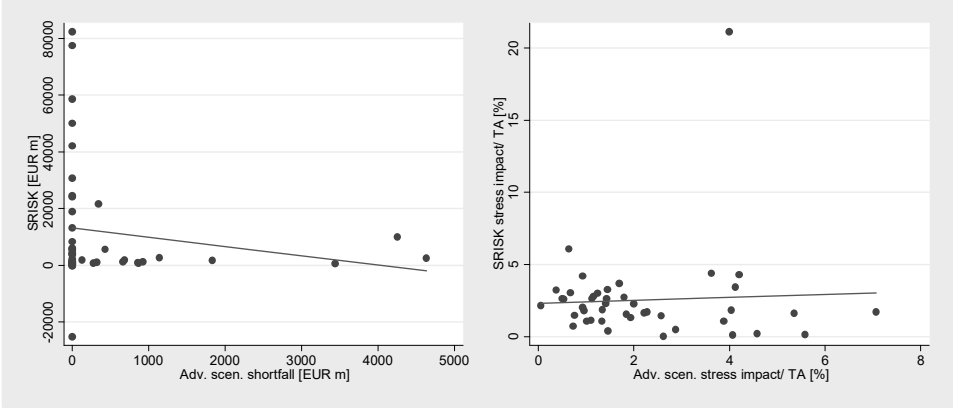


Figure 1: Nominal values of SRISK vs. adverse scenario shortfall (left) and SRISK stress impact scaled by total assets vs. adverse scenario stress impact scaled by total assets (right).

The correlation between SRISK and losses in the stress scenario, however, appears to be positive but this is only due to the fact that Acharya and Steffen (2014c) compute correlations between euro values of both measures. Large banks tend to have large losses and large SRISK. We replicate these results, with the only difference that we compute simple correlations at bank level, instead of rank correlations at country level. In addition to capital shortfall under the adverse scenario, banking book losses, trading book losses and SRISK we include the total stress impact of the adverse scenario and the SRISK stress impact.

[65] The dollar value of SRISK shortfall is referred to just as SRISK.

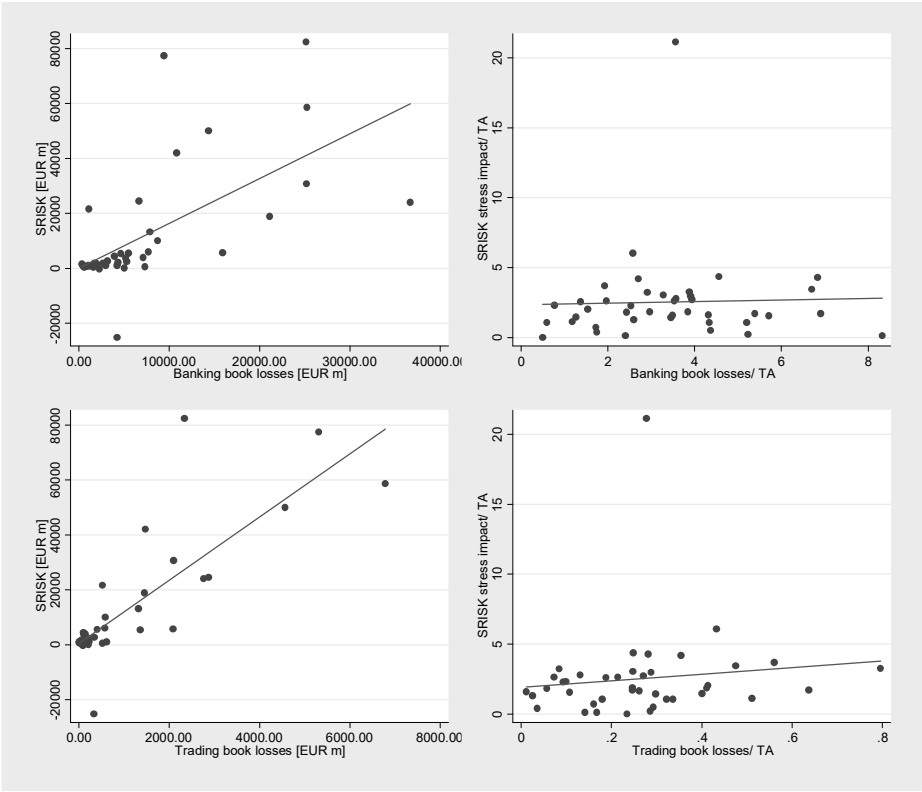


Figure 2: SRISK vs. banking book losses and trading book losses, nominal values (left) and stress impact scaled by total assets (right).

Table 5 reports these results. The values of all measures are nominal amounts in millions of EUR, not scaled by total assets. Thus the correlations are likely due to bank size. In Table 6 we report correlations that do not suffer from this problem. Bank losses under both stress scenarios are scaled by total assets of banks. Instead of to shortfall we compare them to SRISK stress impact. Losses should be compared to losses rather than shortfalls. This comparison shows that the positive correlation between SRISK and banking and trading book losses disappears once the values are scaled by total assets and SRISK stress impact is used instead of the SRISK shortfall, which is also visible from Figure 2. In contrast, adverse scenario stress impact scaled by total assets exhibits a correlation of 0.60 to banking book losses, which are a large component of the stress impact, and a slightly negative correlation to trading book losses.

Table 5: Correlations between nominal values of stress test losses and SRISK.

	Adv. scen. shortfall [EUR m]	Adv. scen. stress impact [EUR m]	Banking book losses [EUR m]	Trading book losses [EUR m]	SRISK stress impact [EUR m]	SRISK [EUR m]
Adv. scen. shortfall [EUR m]	1.00	0.32	-0.12	-0.20	-0.28	-0.18
Adv. scen. stress impact [EUR m]	0.32	1.00	-0.32	0.05	-0.16	-0.03
Banking book losses [EUR m]	-0.12	-0.32	1.00	0.68	0.79	0.63
Trading book losses [EUR m]	-0.20	0.05	0.68	1.00	0.74	0.82
SRISK stress impact [EUR m]	-0.28	-0.16	0.79	0.74	1.00	0.49
SRISK [EUR m]	-0.18	-0.03	0.63	0.82	0.49	1.00

Table 6: Correlations between stress impact scaled by total assets and SRISK stress impact scaled by total assets.

	Adv. scen. stress impact / TA [%]	Banking book losses / TA [%]	Trading book losses / TA [%]	SRISK stress impact / TA [%]
Adv. scen. stress impact / TA [%]	1.00	0.60	-0.08	0.05
Banking book losses / TA [%]	0.60	1.00	0.07	0.03
Trading book losses / TA [%]	-0.08	0.07	1.00	0.12
SRISK stress impact / TA [%]	0.05	0.03	0.12	1.00

To investigate what factors may explain the SRISK stress impact, we regress it on the same set of explanatory variables as the adverse scenario stress impact in Table 2. The results are reported in Table 7. Since SRISK is only available for publicly traded banks, the coverage is limited to about 40 banks corresponding to 50% of total banking assets covered by the CA. The main observation that can be made from Table 7 is that the proportion of explained variance of the SRISK stress impact is very low, with almost no statistically significant coefficients.

The reason that variables that explain the outcomes of the ECB/EBA stress test explain very little variation of the SRISK stress impact is that the model underlying the SRISK measure does not properly account for losses that would wipe out the entire equity of a bank. Rather than modelling the loss of value of assets in case of a shock, as was done in the CA, SRISK models stock returns in case of a shock. In the ECB/EBA stress scenario, the losses under the stress scenario can exceed the capital a bank has prior to the stress. In contrast in the SRISK stress scenario, thinly capitalized banks may experience a large negative stock return, but their equity is not wiped out, however low it may be initially. This bounds the loss of value in the SRISK stress scenario to the initial market value of equity. As a result, the SRISK measure greatly underestimates the loss of value for banks with low initial capital and overestimates the losses for banks with high initial market value of equity. The loss of value expressed as a proportion of book total assets in the SRISK scenario is consequently best explained by the initial market leverage ratio of a bank – higher capitalized banks have more equity to lose, relative to total assets.

Table 7: SRISK stress impact scaled by total assets.

	SRISK stress impact/ TA (1)	SRISK stress impact/ TA (2)	SRISK stress impact/ TA (3)	SRISK stress impact/ TA (4)	SRISK stress impact/ TA (5)	SRISK stress impact/ TA (6)
GDP growth, 3 year	0.1163			0.3315		0.2070
	(0.54)			(0.97)		(0.75)
Govt. bond yield		0.0633				
		(0.72)				
EDF nonfin. sector			-0.4685			
			(-1.42)			
Unemployment, 3 year average			0.8224			
			(1.70)			
Bank activity restr. ind.	-0.2004	-0.3756	-0.6098**	-0.0749	-0.0785	-0.3904
	(-0.76)	(-1.19)	(-2.69)	(-0.28)	(-0.23)	(-0.89)
Capital regulatory ind.	-0.2301	-0.2991	-0.9913*	-0.2313	-0.1892	-0.3660
	(-1.04)	(-1.18)	(-2.13)	(-1.37)	(-0.81)	(-0.98)
Size	0.1456	0.1783	0.1969	0.1806	0.5136**	0.1389
	(1.01)	(1.05)	(0.99)	(0.91)	(2.46)	(0.73)
Book leverage ratio	0.5162	0.4150	0.3287	0.4887	0.8774**	0.4957
	(1.45)	(1.51)	(1.29)	(1.69)	(2.91)	(1.42)
Loans/ TA	0.1074	0.1095	-0.0950	0.1515	0.2386	0.1647
	(0.78)	(0.68)	(-0.30)	(0.80)	(0.72)	(0.98)
RWA/ TA	-0.2669	-0.1427	-0.0444	-0.3356	-0.4115	-0.1431
	(-1.21)	(-0.85)	(-0.36)	(-0.95)	(-0.76)	(-0.71)
ROA	-0.0190	-0.0511	-0.0444	0.0776	0.2949*	-0.0132
	(-0.16)	(-0.39)	(-0.37)	(1.02)	(1.91)	(-0.13)
Impaired loans ratio				0.3666		
				(0.93)		
Bank CDS spread					0.0944	
					(0.49)	
Bank stock 4-factor alpha						-0.0162
						(-0.11)
N of observations	43	40	39	42	30	36
Coverage of bank assets [%]	62.07	61.88	58.30	61.96	52.14	48.20
Adjusted R2	-0.0203	-0.0362	0.0932	0.0625	0.0973	-0.0266

The dependent variable is the stress impact implied by the SRISK capital shortfall, scaled by book total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 8 demonstrates the link between the SRISK stress impact and market leverage ratio very clearly. It compares regressions of ECB stress impact (regressions (1), (2) and (3)) with regressions of the SRISK stress impact (regressions (4), (5) and (6)) on the same set of variables and for an identical sample of banks.[66] In regressions (2) and (5) market leverage ratio is used instead of book leverage ratio, as a control for initial bank capitalization before the stress impact. Using market leverage ratio instead of book leverage ratio does not materially affect estimates of regressions of the ECB stress impact. The estimated effect of market leverage ratio is negative, like the effect of book leverage ratio. Banks with more equity are expected to suffer

[66] Note that the main relationships, the direction of signs and often also significance levels, shown for the adverse scenario stress impact on the full sample also hold for the reduced sample for which SRISK is available.

lower losses. R squared stays at the same level, at about 0.65. In contrast market leverage ratio explains almost the entire variation in the SRISK stress impact. The R squared increases from 0.07 with book leverage ratio to 0.92 with market leverage ratio. In regression (6) market leverage ratio alone explains 89% of the variation in the SRISK stress impact, while it has virtually no explanatory power in case of the adverse scenario stress impact (column (3)). Banks with high initial market capitalization lose much more value in the SRISK stress scenario than those with very low market capitalization.

Table 8: Comparing the ECB adverse scenario stress impact and the SRISK stress impact: the importance of market leverage ratio.

	Adv. scen. stress impact/ TA	**Adv. scen. stress impact/ TA**	**Adv. scen. stress impact/ TA**	**SRISK stress impact/ TA**	**SRISK stress impact/ TA**	**SRISK stress impact/ TA**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
GDP growth, 3 year	-0.3198**	-0.1471		0.3315	-0.0886	
	(-2.52)	(-1.54)		(0.97)	(-0.94)	
Bank activity restr. ind.	-0.3887***	-0.2865*		-0.0749	-0.1394	
	(-3.07)	(-1.92)		(-0.28)	(-1.21)	
Capital regulatory ind.	-0.3850***	-0.3894***		-0.2313	-0.0925	
	(-4.23)	(-4.75)		(-1.37)	(-1.25)	
Size	-0.2077*	-0.1891		0.1806	0.1304*	
	(-1.95)	(-1.60)		(0.91)	(1.91)	
Loans/ TA	-0.0529	-0.0197		0.1515	-0.0070	
	(-0.51)	(-0.19)		(0.80)	(-0.10)	
RWA/ TA	0.3027**	0.0429		-0.3356	-0.0195	
	(2.41)	(0.25)		(-0.95)	(-0.24)	
Impaired loans ratio	0.6268***	0.6484***		0.3666	-0.0212	
	(7.46)	(6.54)		(0.93)	(-0.44)	
ROA	0.0291	0.0215		0.0776	-0.1024	
	(0.33)	(0.22)		(1.02)	(-1.68)	
Book leverage ratio	-0.4037*			0.4887		
	(-1.88)			(1.69)		
Market lev. ratio		-0.1844**	0.0535		0.9639***	0.9446***
		(-2.40)	(0.37)		(11.85)	(9.45)
N of observations	42	42	43	42	42	43
Coverage of bank assets [%]	61.96	61.96	62.07	61.96	61.96	62.07
Adjusted R2	0.6575	0.6217	-0.0215	0.0625	0.9126	0.8896

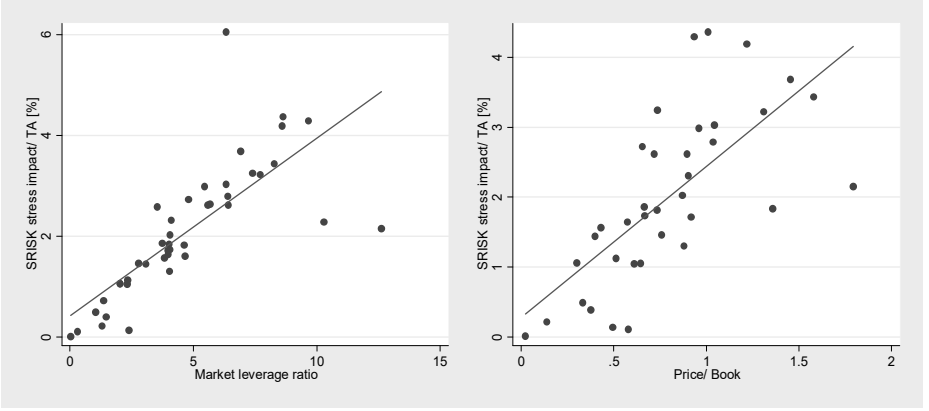
The dependent variables are the adverse scenario stress impact of the ECB stress test and the SRISK stress impact. Both are scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

A positive link between market leverage ratio could be consistent with the explanation that banks with higher market equity have riskier portfolios. The relationship is, however, very strong and almost mechanical, suggesting it is due to the design of the SRISK measure. In order to understand this, it is imperative to recall the expression for SRISK stress impact provided earlier:

$$\frac{SRISK_{Stress\ Impact}}{TA_{Book}} = LRMES * \frac{Equity_{Market}}{TA_{Market}} * \frac{TA_{Market}}{TA_{Book}} \quad (5)$$

The first term results from long term covariances with the market, and while better capitalized banks might engage in more risky behavior than less well capitalized ones, there should and is no strong relationship between leverage ratio and LRMES. The last term can be roughly approximated by 1, since there is typically no large discrepancy between book and market value of debt. While price to book ratio varies much more, it is effectively dominated by debt in the calculation of this ratio, as equity is a far smaller component of bank balance sheets than debt. The middle term is the market leverage ratio, which can be shown do display a large heterogeneity in our sample, effectively dominating the effect of the variation in LRMES.

Figure 3: SRISK stress impact scaled by total assets vs. market leverage ratio (left) and price to book ratio (right).



The sample for the scatterplot with market leverage ratio does not include Allied Irish Banks, which is an outlier with a market leverage ratio of 36%. The observation of Allied Irish banks lies close to the fitted regression line so it does not affect the correlation. We do not plot it to prevent the other observations being collapsed to a small area of the plot.

Similarly, SRISK stress impact is also highly correlated with price to book ratio, which alone explains 47% of the variation in the SRISK stress scenario. Banks with larger price to book ratio are expected to suffer larger losses in the stress scenario. The correlations of SRISK stress impact with market leverage ratio and price to book ratio are depicted in Figure 3. Table 9 provides the regression results for price to book ratio. Book leverage ratio has a marginally significant negative effect on the stress impact of the ECB/EBA adverse scenario; price to book ratio is insignificant. For SRISK stress impact price to book ratio has a highly significant positive effect.

Table 9: Comparing the ECB adverse scenario stress impact and the SRISK stress impact: the importance of price to book ratio.

	Adv. scen. stress impact/ TA	Adv. scen. stress impact/ TA	Adv. scen. stress impact/ TA	SRISK stress impact/ TA	SRISK stress impact/ TA	SRISK stress impact/ TA
	(1)	(2)	(3)	(4)	(5)	(6)
GDP growth, 3 year	-0.3198**	-0.5231***		0.3315	-0.3717***	
	(-2.52)	(-3.40)		(0.97)	(-4.13)	
Bank activity restr. ind.	-0.3887***	-0.2665		-0.0749	-0.3090**	
	(-3.07)	(-1.78)		(-0.28)	(-2.80)	
Capital regulatory ind.	-0.3850***	-0.2082		-0.2313	-0.1579*	
	(-4.23)	(-1.38)		(-1.37)	(-1.88)	
Size	-0.2077*	-0.1846		0.1806	0.4695***	
	(-1.95)	(-1.55)		(0.91)	(4.83)	
Loans/ TA	-0.0529	-0.2379		0.1515	0.2087	
	(-0.51)	(-1.46)		(0.80)	(1.51)	
RWA/ TA	0.3027**	0.3622**		-0.3356	0.1791	
	(2.41)	(2.88)		(-0.95)	(1.20)	
Impaired loans ratio	0.6268***	0.5233***		0.3666	-0.3032*	
	(7.46)	(3.97)		(0.93)	(-2.10)	
ROA	0.0291	0.0478		0.0776	-0.0081	
	(0.33)	(0.37)		(1.02)	(-0.20)	
Book leverage ratio	-0.4037*	-0.4674*		0.4887	0.2473	
	(-1.88)	(-2.03)		(1.69)	(0.95)	
P/B ratio		-0.0357	-0.1674		0.7196***	0.6982***
		(-0.27)	(-0.76)		(11.15)	(4.37)
N of observations	42	35	36	42	35	36
Coverage of bank assets [%]	61.96	47.73	47.85	61.96	47.73	47.85
Adjusted R2	0.6575	0.6376	-0.0006	0.0625	0.7288	0.4724

The dependent variables are the adverse scenario stress impact of the ECB stress test and the SRISK stress impact. Both are scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

In order to check, whether SRISK performs better when evaluated in a way it is originally modelled, i.e. in terms of stock returns, we scale SRISK stress impact by initial market capitalization of banks. Loss of value in the SRISK stress scenario divided by market capitalization approximates the stock return over the 6 month period in the SRISK stress scenario. Table 11 in the Appendix on page 127 reports these results. GDP growth and quality of banking supervision measures now have a significant effects with the expected negative sign.[67] However, the effects of market leverage ratio and price to book ratio are still dominant. In addition the negative return on equity in the stress scenario seems to be smaller for banks with higher impaired loans ratio, which is in conflict with economic intuition. This analysis shows that SRISK is inappropriate as a measure of expected bank losses in a stress scenario.

[67] Note that a larger SRISK stress impact / initial market capitalization should be interpreted as a negative stock return large in absolute value.

Consequently the shortfalls computed based on the SRISK stress scenario do not properly reflect the capital needed for banks to withstand an adverse stress scenario.

Table 10: Comparison of the stress impact of the ECB/EBA adverse scenario with SRISK stress impact, by bank.

Bank	Total assets	Market leverage ratio	SRISK stress impact/ TA	Adv. s. stress impact/ TA	SRISK stress impact/ Mcap.	Adv. s. stress impact/ Mcap.	SRISK impact/ Adv. s. impact
Dexia	222,936	0.02	0.01	2.62	27.32	7,402.3	0.00
Österreichische VB	20,904	2.39	0.13	5.59	10.15	423.2	0.02
Hellenic Bank	6,384	0.32	0.11	4.07	14.28	534.8	0.03
Bank of Cyprus	30,342	1.31	0.21	4.58	16.55	359.8	0.05
Banca Monte dei Paschi	198,461	1.03	0.49	2.88	46.89	275.9	0.17
Eurobank Ergasias	77,586	3.96	1.71	7.07	42.81	177.2	0.24
IKB Deutsche Industriebank	27,617	1.46	0.39	1.46	26.22	98.6	0.27
Banca Carige	42,156	2.31	1.05	3.88	39.36	145.9	0.27
Permanent TSB Group	37,601	4.65	1.61	5.35	35.94	119.7	0.30
Banco Comercial Português	82,007	4.02	1.84	4.04	45.37	99.7	0.46
Banca Popolare di Milano	49,353	3.09	1.44	2.57	48.29	86.2	0.56
Banco BPI	42,700	4.05	1.30	1.93	30.33	45.2	0.67
Banca popolare dell'Emilia	61,758	3.99	1.64	2.21	43.22	58.4	0.74
Banca Popolare di Sondrio	32,770	4.06	1.73	2.28	43.26	57.2	0.76
Banco Popolare	126,043	2.03	1.06	1.34	53.79	67.9	0.79
National Bank of Greece	110,930	8.29	3.43	4.13	40.08	48.2	0.83
UBI Banca	124,242	3.82	1.56	1.85	43.10	50.9	0.85
Crédit Agricole Group	1,688,541	1.36	0.71	0.73	43.96	45.3	0.97
Commerzbank	549,654	2.34	1.12	1.11	46.64	46.0	1.01
Alpha Bank	73,697	9.67	4.29	4.20	45.23	44.3	1.02
Deutsche Bank AG	1,611,400	2.04	1.05	1.02	46.36	44.8	1.04
OP-Pohjola Group	100,991	10.29	2.27	2.00	42.58	37.4	1.14
Piraeus Bank	92,010	8.64	4.36	3.62	51.11	42.5	1.20
UniCredit	827,538	3.74	1.86	1.34	49.98	36.1	1.39
Intesa Sanpaolo	624,179	4.80	2.72	1.80	49.37	32.6	1.51
Aareal Bank	42,981	4.12	2.31	1.41	56.79	34.6	1.64
Banco Popular Español	146,709	5.58	2.62	1.43	45.75	25.0	1.83
Banco de Sabadell	163,441	4.63	1.82	0.96	38.24	20.1	1.90
Société Générale	1,214,193	2.78	1.46	0.76	48.87	25.4	1.92
BNP Paribas	1,810,522	4.05	2.02	0.93	46.50	21.4	2.17
KBC Group	238,686	6.92	3.68	1.69	51.01	23.5	2.17
Mediobanca	75,285	7.40	3.24	1.44	44.35	19.8	2.24
Credito Emiliano	31,531	6.42	2.62	1.13	37.83	16.3	2.32
Erste Group Bank	200,118	5.45	2.98	1.24	53.44	22.2	2.41
Bank of Ireland	132,133	6.40	2.78	1.15	40.55	16.8	2.42
Banco Santander	1,115,637	6.33	3.03	0.68	45.38	10.1	4.49
BBVA	582,575	8.61	4.19	0.93	46.91	10.4	4.52
ING Bank	787,644	3.54	2.58	0.54	51.66	10.9	4.74
Caja de Ahorros Barcelona	351,269	5.67	2.63	0.50	46.43	8.9	5.22
Allied Irish Banks	117,734	35.97	21.13	3.99	42.09	7.9	5.30
Bankinter	55,136	7.72	3.22	0.38	38.73	4.6	8.44
Nordea Bank Finland	304,761	6.34	6.05	0.64	45.93	4.9	9.42
HSBC Bank Malta	5,722	12.61	2.15	0.06	14.36	0.4	36.88

Total assets and market capitalization are in million EUR. Market leverage ratio and stress impacts are reported in percent. SRISK impact / Adv. scen. impact is the ratio of the SRISK stress impact over the adverse scenario stress impact. Banks are sorted according to this ratio. At the top of the table are banks that lose very little value in the SRISK stress scenario compared to the value they are expected to lose in the adverse stress scenario of the ECB stress test. At the bottom of the table are banks that suffer large losses under in the SRISK stress scenario relative to their losses in the adverse scenario of the ECB stress test. For a more extensive version of this table that also reports market capitalization, Tier 1 ratio and book leverage ratio of banks see Table 12 in the Appendix on page 128.

To illustrate the extent to which the stress impact of the ECB stress test and the SRISK stress impact differ, Table 10 compares the adverse scenario stress impact and the SRISK stress impact, sorting banks by the ratio of the SRISK stress impact relative to the adverse scenario stress impact. This confirms that for the poorly capitalized banks such as Dexia, Hellenic Bank, Banca Monte Paschi di Sienna, etc., the SRISK stress impact is only a small fraction of the impact under the adverse stress scenario. Likewise, for the highly capitalized banks such as Nordea Bank Finland, the SRISK stress impact is higher than the impact of the ECB stress test by a factor of 10.

When looking at the SRISK impact relative to the initial market capitalization of a bank i.e. the return equity investors would suffer in the stress scenario, the SRISK figures range from 10% to 55%, which corresponds to the 40% drop in the general stock market. In contrast the range of losses in the SRISK stress scenario, relative to total assets spans from 0.96% to 21% of total assets of a bank. Given that small losses are associated with weakly capitalized banks and large ones with banks that have high market capitalization relative to total assets, such dispersion clearly shows that the measure is unsuitable for estimating vulnerability of banks. The stress impact in the adverse scenario of the ECB/EBA stress test shows the opposite pattern. Losses relative to total assets range from 0.06% to 7%. Banks with low initial market value of equity lose a multiple of their equity value (up to 7400%) and well capitalized banks suffer only small losses relative to their market capitalization (less than 10%).

6.6 Robustness checks

To check the robustness of our results we perform additional regressions and report the results in the Appendix to this paper. First, we check whether scaling the stress impact by risk weighted assets instead of by total assets affects the results. Table 13 reports regressions with adverse scenario stress impact scaled by RWA. Explanatory variables are the same as in Table 2 apart from that we use Tier 1 capital ratio instead of book capital ratio and do not include risk weighted to total assets ratio. Because the dependent variable is already scaled by RWA there is no need to include RWA ratio as a control. The signs of estimated coefficients are mostly the same as when scaling by total assets. R squared is noticeably lower. The effect of impaired loans is not significant and higher Tier 1 ratio is associated with higher stress impact, while in the specifications scaled by total assets the effect of book leverage ratio was insignificant or negative.

Throughout the analysis we focused on the adverse scenario stress impact of the ECB/EBA stress test. In Table 14 we report results with the baseline scenario stress impact as the dependent variables. The results are very similar but the significance levels of estimated

coefficients and R squared ratios are lower compared to the regressions for the adverse scenario, which is expected given that the variation of the stress impact across banks is lower in the baseline scenario.

6.7 Conclusions

A number of policy papers by Acharya and Steffen (2014a,b) that raise doubt on robustness of the ECB stress test, using SRISK as a benchmark, motivate a deeper analysis of the way stress is modelled in order to assess which results are credible. Accounting for size reveals that the stress impact on bank capital implied by SRISK is only marginally correlated with the stress impact as modelled for the ECB/EBA stress test, and key components thereof such as credit losses and trading losses.

The fundamental differences in the construction of SRISK stress impact and ECB/EBA stress test impact are reflected in the results of the multivariate regression analysis. On the one hand, the ECB/EBA stress test impact, and in particular the losses in the banking book, can be understood in terms of risk factors associated with credit losses. They also can be explained by market based measures of bank vulnerability such as CDS spreads, while trading book losses display a more idiosyncratic behavior, after controlling for the proportion of trading book assets in total assets.

SRISK stress impact, on the other hand, is rather disconnected from both basic risk factors related to credit losses and market implied measures of bank vulnerability.[68] It seems implausible that bank losses in a stress scenario are unrelated to existing default frequencies in the corporate sector, impaired loan ratios etc., even on the six month horizon of the SRISK stress. While the turmoil of 2008 illustrated how banks can be brought into jeopardy not by the original credit losses but also by secondary exacerbating factors such as illiquidity spirals and fire sales, the impact of credit losses on bank risk cannot be negated. While our analysis can neither verify the results obtained by the ECB/EBA stress test nor the SRISK results, it facilitates an intuitive understanding of the main drivers behind the results.

SRISK stress impact is highly positively correlated with market leverage ratio, and also with price to book ratio, with R squared in univariate regressions reaching 90% and 50% respectively. In other words, banks with a high ratio of equity to total assets are proportionally hit harder by the stress. To a certain extent this could be explained by riskier asset portfolios,

[68] While public backstops and gambling on bail-outs participation of debt holders could explain this to a certain extent, it would nevertheless be brave to argue that CDS spreads are therefore not informative.

but certainly not linearly to the extent found in the data. Furthermore, there is no reason why banks with a higher price to book ratio should suffer larger losses.

The findings suggest a rather mechanical relationship between SRISK stress impact and market leverage ratio, which can be explained by decomposing the analytical formula for SRISK stress impact appropriately. If heterogeneity in market leverage ratios is large, this is likely to dominate the heterogeneity in covariance of bank stock returns with the market index, and the market leverage becomes the driving factor behind the SRISK stress impact. This explains why SRISK and ECB stress test results diverge in particular for banks that are close to bankruptcy and banks that are extremely well capitalized.

The SRISK stress scenario is set up to model returns to equity holders; therefore the stress impact is bounded by the amount of equity. This is particularly worrying for banks that are initially insufficiently capitalized, where the limit on losses is most likely binding in a stress scenario. We show that this has severe practical implications, namely the SRISK stress impact is lower than what the ECB stress test finds up to a factor of 270 for the least well capitalized bank.

While not denying the usefulness of market implied measures of bank risk, we argue that the stress impact would have to be calculated relative to the total balance sheet. The difficulty in using a measure based on stock returns is to properly model losses in states where all equity is wiped out. The ECB/EBA stress test, on the other hand, models the entire asset side and thus captures the whole balance sheet; the challenges with this approach lie rather in the modelling of the stress scenario and losses of different asset classes.

6.8 Appendix

6.8.1 Weighting scheme

We use data on bank exposures to 67 different countries to weight variables describing macroeconomic conditions. These data are from ECB and have a few limitations that need to be addressed. Firstly, total exposures are not always equal to total assets. However, in most cases, more than 90% of assets are covered. Secondly, data on some exposures are missing for 30 banks in the AQR sample. We scale up other exposures of these banks so that they sum up to 100% of total assets. Then we assume that the banks, for which exposure data is missing completely, are only exposed to the country they are headquartered in. Given that the covered banks have an average exposure of 73% to their home country, this is a reasonable approximation. Lastly, macroeconomic data is not available for all countries banks can have exposures to. We deal with this problem as follows: If for example government bond yield data for Luxemburg is missing, for the specific purpose of calculating the weighted government bond yield, the exposure of all banks towards Luxemburg is dropped and the remaining exposures are scaled up to sum to 100%. However, this procedure is only applied if the macroeconomic variable is available for the country the financial institution is headquartered in. If not, the macroeconomic variable is treated as missing for such a bank.

6.8.2 SRISK additional regressions

Table 11: SRISK stress impact scaled by market value of equity before the shock.

	SRISK stress impact/ MCAP (1)	SRISK stress impact/ MCAP (2)	SRISK stress impact/ MCAP (3)	SRISK stress impact/ MCAP (4)	SRISK stress impact/ TA (5)	SRISK stress impact/ TA (6)
GDP growth, 3 year	-0.1956**	-0.3585***		-0.1655	-0.0886	-0.3717***
	(-2.43)	(-3.34)		(-1.32)	(-0.94)	(-4.13)
Bank activity restr. ind.	-0.1543	-0.3530**	-0.3254	-0.4062*	-0.1394	-0.3090**
	(-1.13)	(-2.25)	(-1.12)	(-2.17)	(-1.21)	(-2.80)
Capital regulatory ind.	-0.3314**	-0.3663***	-0.5175*	-0.5278**	-0.0925	-0.1579*
	(-2.63)	(-3.42)	(-2.05)	(-2.93)	(-1.25)	(-1.88)
Size	0.7838***	0.6870***	0.6860**	0.7785***	0.1304*	0.4695***
	(5.44)	(4.31)	(2.82)	(6.15)	(1.91)	(4.83)
Book leverage ratio	0.0303	0.1175	0.2333	-0.0016		0.2473
	(0.12)	(0.47)	(0.51)	(-0.01)		(0.95)
Market lev. ratio					0.9639***	
					(11.85)	
P/B ratio						0.7196***
						(11.15)
Loans/ TA	0.4026**	0.3483***	0.3981	0.3736**	-0.0070	0.2087
	(2.71)	(3.06)	(1.55)	(2.46)	(-0.10)	(1.51)
RWA/ TA	-0.1402	-0.0743	0.0401	-0.0302	-0.0195	0.1791
	(-0.46)	(-0.33)	(0.09)	(-0.09)	(-0.24)	(1.20)
ROA	0.0604	-0.0603	-0.0891	0.0755	-0.1024	-0.0081
	(0.88)	(-0.96)	(-0.74)	(1.25)	(-1.68)	(-0.20)
Impaired loans ratio		-0.3842**			-0.0212	-0.3032*
		(-2.44)			(-0.44)	(-2.10)
Bank CDS spread			-0.1001			
			(-0.49)			
Bank stock 4-factor alpha				0.0240		
				(0.11)		
N of observations	43	42	30	36	42	35
Coverage of bank assets [%]	62.07	61.96	52.14	48.20	61.96	47.73
Adjusted R2	0.5134	0.5517	0.0591	0.4653	0.9126	0.7288

The dependent variable is the stress impact implied by the SRISK capital shortfall scaled by the market value of equity before the shock. This way SRISK stress impact can be interpreted as the negative return on bank stock as a result of the shock in the stress scenario. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

6.8.3 Comparison of the ECB stress test impact and the SRISK stress impact

Table 12: Comparison of the adverse stress impact (of the ECB stress test) with SRISK stress impact, by bank.

Bank	Total assets	Market cap.	Tier 1 ratio	Market lev. ratio	Book lev. ratio	SRISK stress impact/ TA	Adv. s. stress impact/ TA	SRISK stress impact/ Mcap.	Adv. s. stress impact/ Mcap.	SRISK impact/ Adv. s. impact
Dexia	222,936	79	0.21	0.02	1.78	0.01	2.62	27.32	7,402.3	0.00
Österreichische VB	20,904	536	0.14	2.39	5.84	0.13	5.59	10.15	423.2	0.02
Hellenic Bank	6,384	48	0.13	0.32	6.25	0.11	4.07	14.28	534.8	0.03
Bank of Cyprus	30,342	378	0.10	1.31	9.00	0.21	4.58	16.55	359.8	0.05
Banca Monte dei Paschi	198,461	2,078	0.11	1.03	3.11	0.49	2.88	46.89	275.9	0.17
Eurobank Ergasias	77,586	3,061	0.11	3.96	5.83	1.71	7.07	42.81	177.2	0.24
IKB Deutsche Industriebank	27,617	366	0.10	1.46	4.07	0.39	1.46	26.22	98.6	0.27
Banca Carige	42,156	984	0.06	2.31	3.90	1.05	3.88	39.36	145.9	0.27
Permanent TSB Group	37,601	1,664	0.13	4.65	6.34	1.61	5.35	35.94	119.7	0.30
Banco Comercial Português	82,007	3,320	0.13	4.02	3.99	1.84	4.04	45.37	99.7	0.46
Banca Popolare di Milano	49,353	1,474	0.08	3.09	7.39	1.44	2.57	48.29	86.2	0.56
Banco BPI	42,700	1,711	0.16	4.05	5.40	1.30	1.93	30.33	45.2	0.67
Banca popolare dell'Emilia	61,758	2,341	0.09	3.99	7.63	1.64	2.21	43.22	58.4	0.74
Banca Popolare di Sondrio	32,770	1,309	0.08	4.06	6.14	1.73	2.28	43.26	57.2	0.76
Banco Popolare	126,043	2,493	0.11	2.03	6.76	1.06	1.34	53.79	67.9	0.79
National Bank of Greece	110,930	9,340	0.11	8.29	7.10	3.43	4.13	40.08	48.2	0.83
UBI Banca	124,242	4,513	0.13	3.82	9.00	1.56	1.85	43.10	50.9	0.85
Crédit Agricole Group	1,688,541	23,565	0.13	1.36	4.84	0.71	0.73	43.96	45.3	0.97
Commerzbank	549,654	13,518	0.13	2.34	4.90	1.12	1.11	46.64	46.0	1.01
Alpha Bank	73,697	6,978	0.16	9.67	11.35	4.29	4.20	45.23	44.3	1.02
Deutsche Bank AG	1,611,400	35,845	0.17	2.04	3.41	1.05	1.02	46.36	44.8	1.04
OP-Pohjola Group	100,991	4,749	0.17	10.29	7.65	2.27	2.00	42.58	37.4	1.14
Piraeus Bank	92,010	7,853	0.14	8.64	9.28	4.36	3.62	51.11	42.5	1.20
UniCredit	827,538	31,600	0.11	3.74	6.05	1.86	1.34	49.98	36.1	1.39
Intesa Sanpaolo	624,179	29,581	0.12	4.80	7.22	2.72	1.80	49.37	32.6	1.51
Aareal Bank	42,981	1,747	0.19	4.12	5.70	2.31	1.41	56.79	34.6	1.64
Banco Popular Español	146,709	8,415	0.12	5.58	7.92	2.62	1.43	45.75	25.0	1.83
Banco de Sabadell	163,441	7,671	0.12	4.63	6.37	1.82	0.96	38.24	20.1	1.90
Société Générale	1,214,193	34,130	0.13	2.78	4.44	1.46	0.76	48.87	25.4	1.92
BNP Paribas	1,810,522	71,364	0.13	4.05	5.02	2.02	0.93	46.50	21.4	2.17
KBC Group	238,686	17,411	0.16	6.92	6.08	3.68	1.69	51.01	23.5	2.17
Mediobanca	75,285	5,553	0.12	7.40	9.85	3.24	1.44	44.35	19.8	2.24
Credito Emiliano	31,531	1,960	0.10	6.42	6.84	2.62	1.13	37.83	16.3	2.32
Erste Group Bank	200,118	11,039	0.12	5.45	7.39	2.98	1.24	53.44	22.2	2.41
Bank of Ireland	132,133	8,257	0.12	6.40	5.97	2.78	1.15	40.55	16.8	2.42
Banco Santander	1,115,637	74,613	0.13	6.33	7.16	3.03	0.68	45.38	10.1	4.49
BBVA	582,575	52,419	0.12	8.61	7.70	4.19	0.93	46.91	10.4	4.52
ING Bank	787,644	39,256	0.14	3.54	4.29	2.58	0.54	51.66	10.9	4.74
Caja de Ahorros Barcelona	351,269	19,008	0.13	5.67	7.75	2.63	0.50	46.43	8.9	5.22
Allied Irish Banks	117,734	59,111	0.14	35.97	8.91	21.13	3.99	42.09	7.9	5.30
Bankinter	55,136	4,522	0.13	7.72	6.17	3.22	0.38	38.73	4.6	8.44
Nordea Bank Finland	304,761	40,172	0.16	6.34	3.12	6.05	0.64	45.93	4.9	9.42
HSBC Bank Malta	5,722	768	0.09	12.61	7.39	2.15	0.06	14.36	0.4	36.88

Total assets and market capitalization are in million EUR. Tier 1 ratio, leverage ratios and stress impacts are reported in percent. SRISK impact / Adv. scen. impact is the ratio of the SRISK stress impact over the adverse scenario stress impact. Banks are sorted according to this ratio. At the top of the table are banks that lose very little value in the SRISK stress scenario compared to the value they are expected to lose in the adverse stress scenario of the ECB stress test. At the bottom of the table are banks that suffer large losses under in the SRISK stress scenario relative to their losses in the adverse scenario of the ECB stress test.

6.8.4 Robustness checks

Table 13: Adverse scenario stress impact, scaled by risk weighted assets.

	Adv. scen. stress impact/ RWA (1)	Adv. scen. stress impact/ RWA (2)	Adv. scen. stress impact/ RWA (3)	Adv. scen. stress impact/ RWA (4)	Adv. scen. stress impact/ RWA (5)	Adv. scen. stress impact/ RWA (6)
GDP growth, 3 year	-0.4512***			-0.4497***		-0.5151***
	(-6.17)			(-4.41)		(-9.05)
Govt. bond yield		0.3110*				
		(2.06)				
EDF nonfin. sector			0.0363			
			(0.18)			
Unemployment, 3 year average			0.0291			
			(0.11)			
Bank activity restr. ind.	-0.2861**	-0.2294	-0.0517	-0.3662***	-0.1053	-0.2021
	(-2.47)	(-1.32)	(-0.22)	(-3.93)	(-0.74)	(-1.27)
Capital regulatory ind.	-0.2499*	-0.2531	-0.1644	-0.3277**	-0.1278	-0.2250
	(-1.80)	(-1.61)	(-0.57)	(-2.53)	(-0.81)	(-1.75)
Size	-0.1512*	-0.0797	-0.0974	-0.1915**	-0.0409	-0.0995
	(-2.04)	(-0.76)	(-1.05)	(-2.64)	(-0.38)	(-1.51)
Tier 1 ratio	0.3075***	0.2524**	0.1677	0.2979***	0.4003	0.3255*
	(3.21)	(2.40)	(1.51)	(3.25)	(1.65)	(1.81)
Loans/ TA	-0.1663**	-0.1476**	-0.1590	-0.2541***	-0.2144**	-0.2201
	(-2.67)	(-2.42)	(-1.50)	(-3.06)	(-2.49)	(-1.54)
ROA	-0.3128***	-0.3336***	-0.3573***	-0.2623**	-0.1227	-0.1614
	(-3.64)	(-3.27)	(-4.16)	(-2.19)	(-1.14)	(-0.84)
Impaired loans ratio				0.1137		
				(0.82)		
Bank CDS spread					0.5626***	
					(6.06)	
Bank stock 4-factor alpha						-0.1134
						(-0.33)
N of observations	120	107	105	105	51	41
Coverage of bank assets [%]	97.99	97.03	88.01	92.08	67.71	48.63
Adjusted R2	0.2824	0.2533	0.1385	0.3481	0.3522	0.3545

The dependent variable is adverse scenario stress impact. In this robustness check it is expressed in percent of risk weighted assets as it is originally reported. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Table 14: Baseline scenario stress impact.

	Base. scen. stress impact/ TA (1)	Base. scen. stress impact/ TA (2)	Base. scen. stress impact/ TA (3)	Base. scen. stress impact/ TA (4)	Base. scen. stress impact/ TA (5)	Base. scen. stress impact/ TA (6)
GDP growth, 3 year	-0.2266			-0.1588		-0.5639**
	(-1.41)			(-1.15)		(-2.40)
Govt. bond yield		0.3745***				
		(3.78)				
EDF nonfin. sector			0.1034			
			(0.80)			
Unemployment, 3 year average			0.2057			
			(0.91)			
Bank activity restr. ind.	-0.3383**	-0.3930**	-0.3599	-0.3831***	-0.1980	-0.1829
	(-2.22)	(-2.51)	(-1.72)	(-3.28)	(-1.45)	(-0.97)
Capital regulatory ind.	-0.3220**	-0.3572***	-0.4113*	-0.3997***	-0.0945	-0.2623*
	(-2.67)	(-3.31)	(-1.83)	(-3.49)	(-0.94)	(-1.80)
Size	-0.1429	-0.1361	-0.1887*	-0.1224	-0.3638**	-0.1239
	(-1.51)	(-1.73)	(-1.96)	(-1.21)	(-2.27)	(-0.64)
Book leverage ratio	-0.0073	0.0035	-0.1315	-0.0049	-0.2983	-0.1903
	(-0.06)	(0.03)	(-0.88)	(-0.04)	(-0.82)	(-0.58)
Loans/ TA	-0.1276	-0.0577	-0.1614	-0.1032	-0.2968*	-0.0140
	(-1.51)	(-0.64)	(-1.33)	(-1.02)	(-2.03)	(-0.10)
RWA/ TA	0.0465	-0.0151	0.0836	-0.0369	0.1861	-0.3920
	(0.41)	(-0.13)	(0.67)	(-0.45)	(1.08)	(-1.13)
ROA	-0.2712	-0.3892***	-0.4601***	-0.1869	-0.3234	-0.0352
	(-1.49)	(-5.76)	(-6.59)	(-0.92)	(-1.64)	(-0.15)
Impaired loans ratio				0.2129		
				(1.23)		
Bank CDS spread					0.5569***	
					(4.50)	
Bank stock 4-factor alpha						-0.3010
						(-1.06)
N of observations	121	108	105	105	51	41
Coverage of bank assets [%]	98.33	97.36	88.01	92.08	67.71	48.63
Adjusted R2	0.1300	0.2875	0.2119	0.1615	0.2971	0.1837

The dependent variable is baseline scenario stress impact scaled by total assets. Regressions are estimated using OLS with standard errors clustered at country level. In parentheses are t-statistics. Significance levels of 0.10, 0.05 and 0.01 are denoted by *, **, ***, respectively.

Chapter 7
Conclusions

The consequences of systemic banking crises are severe as can be seen from the long recessions that often follow them. Governments and central banks intervene during banking crises to preserve financial stability and limit output losses. This thesis investigates how effective intervention measures are and what can be done to detect problems in the banking sector early. The common theme of all chapters is the problems related to undercapitalized banks. In the first two chapters, I analyze the effects of intervention measures targeted at distressed banks from the macro and micro perspective. Then I take a closer look at forbearance, one of the key problems characteristic for undercapitalized banks, asking whether it can be predicted from observable indicators at bank and country level. Finally, I compare two approaches for evaluating bank resilience, a stress test and a market implied measure of capital shortfall.

In Chapter 2, I analyze recessions related to systemic banking crises. Banks that continue to operate under regulatory forbearance despite being undercapitalized do not perform their intermediation role well. They are likely to turn into zombie banks that ration credit to new borrowers but continue to renew loans to insolvent borrowers to delay recognition of losses. Such behavior leads to inefficient allocation of resources and manifests itself in longer recessions. I find that recapitalizing distressed banks considerably mitigates these problems. It reduces the expected recession duration by almost a half. Other measures such as liquidity support, guarantees on bank liabilities, monetary and fiscal policy, which do not address the undercapitalization problem of banks directly, seem to be less effective.

In Chapter 3, I focus on the effects of bank recapitalizations at bank level. I find that after a distressed bank is recapitalized, it increases lending, attracts more deposits and is able to borrow more on the interbank market. It also cleans up its balance sheet, which is visible in a temporary increase in provisions for loan losses. However, these effects are only present if the recapitalization amount is large enough. Banks that receive a small recapitalization relative to their capital shortfall respond differently. They reduce lending and shrink assets presumably to

improve their capital ratio. At the same time they experience an outflow of deposits and borrow less on the interbank market. These results suggest recapitalizations need to be large enough in order to achieve their desired effects.

In Chapter 4, I look at forbearance, a practice of extending or renewing loans to borrowers in distress. Forbearing on some borrowers can be economically justified. However, if it is extensive, which is often the case in banking crises, its purpose is likely to be to delay recognition of losses or gamble for resurrection. Because it is at the discretion of banks whether to forbear a loan or not, the extent of forbearance is difficult to measure. I use the outcomes of the asset quality review performed by the ECB in 2014 to construct measures of forbearance. The results, which show that adverse macroeconomic conditions, lax bank supervision and indicators of bank weakness predict the extent of forbearance across banks, point at the importance of the quality of bank supervision and sufficient capitalization of banks to prevent forbearance from becoming widespread.

In Chapter 5, I compare two approaches for assessing bank vulnerability to severe shocks. Stress tests conducted by central banks typically specify an adverse macroeconomic scenario, under which the losses on different asset classes are estimated. The losses are then aggregated and the total impact on bank capital is computed. In contrast measures based on bank stock returns, such as SRISK, derive information about the expected loss of capital in a stress scenario from past stock returns. The comparison of the outcomes of the ECB/EBA 2014 stress test with SRISK shows that while the variation in losses across banks in the ECB/EBA stress test can be explained by macroeconomic conditions, bank balance sheet variables and market measures, the losses implied by SRISK are largely driven by the initial leverage ratio, which points at a possible large bias in favor of weakly capitalized banks and against banks with high initial capital. The advantage of measures based on market data is that they can be computed on a continuous basis but, as this analysis shows, they may miss on some very important risks.

This thesis shows that leaving banks undercapitalized can result in disastrous outcomes and that recapitalizations are effective. The need for bank recapitalizations from public funds can be reduced if regulators are able to force banks to issue equity on the market before their losses become too large. Identifying drivers of forbearance could help to detect problems in the banking sector early. Stress tests are also a crucial tool to assess bank vulnerability. It is important to check how stress tests and other measures of bank risk perform as them may have critical shortcomings. Carefully analyzing intervention measures and approaches for monitoring risk, can contribute to preventing the next crisis or to a better response when it occurs.

Appendix: Bank Recapitalizations

Table A1: Bank recapitalizations in systemic banking crises in the period 2008-2013.

For explanation on how the dataset is constructed see Chapter 3, Section 3.5.2 and Chapter 4, Section 4.4. Note that the dataset is used in two chapters but not all recapitalizations listed in this table are used in each of the chapters. For a list of banking crises that are part of the analysis in Chapter 3 and a list of banks analyzed in Chapter 4 see the relevant sections in both chapters.

Country	Date	Bank	Recap amount	Description
Austria	2008 Dec	Hypo Alpe Adria	EUR 1.60 bn	Hypo Alpe Adria: Capital injection of EUR 700m from Bayern LB which itself received state support from Germany, and EUR 900m in Tier-1 instruments from Republic of Austria in December 2008. Source: State aid SA.32554 (2009/C)
Austria	2009 Mar	Erste Group	EUR 1.00 bn	Erste Group: EUR 1bn capital injection in March 2009. Source: Finance Ministry of Austria; Erste Group Annual Report 2009
Austria	2009 Apr	RZB Group	EUR 1.75 bn	RZB group: EUR 1,750m capital injection in April. Source: Finance Ministry of Austria; RZB Group Annual report 2009
Austria	2009 Apr	Österreichische Volksbanken	EUR 1.00 bn	Österreichische Volksbanken: EUR 1bn capital injection in the form of participation certificates in April 2009. Source: State aid SA.31883 (N516/2010)
Austria	2009 May	Erste Group	EUR 0.22 bn	Erste Group: EUR 224m capital injection in the form of participation certificates in May 2009. Source: Finance Ministry of Austria; Erste Group Annual Report 2009
Austria	2009 Nov	Bawag	EUR 0.55 bn	Bawag: EUR 550m capital injection in November 2009. Source: State aid N 261/2010 (ex PN 9/2010)
Austria	2009 Nov	KA Finanz	EUR 0.25 bn	KA Finanz: Capital injection of EUR 250m in November 2009. Source: State aid SA.32745 (2011/NN)
Austria	2009 Dec	Hypo Alpe Adria	EUR 0.55 bn	Hypo Alpe Adria nationalized and capital injection of EUR 550m in December 2009. Source: State aid SA.32554 (2009/C)
Austria	2012 Dec	Hypo Alpe Adria	EUR 0.50 bn	Hypo Alpe Adria: Capital injection of EUR 500m in December 2012. Source: State aid SA.32554 (2009/C)
Belgium	2008 Oct	Dexia	EUR 3.00 bn	Dexia: Capital injections of EUR 3bn by Belgian state and regions (Dexia also received EUR 3bn of capital injections from France, and Dexia's Luxembourg subsidiary EUR 376m from Luxembourg in the form of convertible bonds) in October 2008. Source: State aid C 9/2009 (ex NN 49/2008)

Belgium	2008 Oct	Fortis	EUR 4.70 bn	Fortis: On 28 September 2008 Belgian government announced it will inject EUR 4.7bn of capital to acquire a 49.9% share in Fortis Bank SA/NV (Fortis overall banking division but not Fortis holding). On October 3 Belgian government purchased the remaining 51.1% of Fortis Bank for EUR 4.7bn (purchase, not capital injection, therefore not counted as recapitalization). Belgium also announced that it will sell 75% share in Fortis Bank to BNP Paribas for EUR 8.25bn. On October 3 2008 Dutch government announced it purchased FBN, a subsidiary of Fortis with ABN Amro assets, for EUR 12.8bn and Fortis Insurance Netherlands for EUR 4bn. The Luxembourg Government granted Fortis Bank Luxembourg a three-year convertible loan of EUR 2.5bn, which was later converted into equity stake of 49%. Subsequently Luxembourg government sold 16% of Fortis Bank Luxembourg to BNP Paribas that has already acquired 50% of it by purchasing Fortis Bank. Source: State aid NN 42/2008
Belgium	2008 Dec	KBC	EUR 3.50 bn	KBC: Capital injection of EUR 3.5bn by Belgian state in December 2008. Source: State aid C 18/2009 (ex N 360/2009)
Belgium	2009 Q3	KBC	EUR 3.50 bn	KBC: Capital injections of EUR 3.5bn by Flemish government, approved by the EC on 30 June 2009. Source: State aid C 18/2009 (ex N 360/2009)
Belgium	2012 Dec	Dexia	EUR 2.90 bn	Dexia: Capital injection by Belgium EUR 2.9bn (and France EUR 2.6bn) in December 2012. Source: IMF Country Report No. 13/124; Dexia Annual Report 2012
Cyprus	2012 Jun	Cyprus Popular Bank	EUR 1.80 bn	Cyprus Popular Bank: EUR 1,796m capital injection in June 2012. The state acquires 84% share. Source: State aid SA.34827 (2012/NN)
Cyprus	2013 Mar	Cyprus Popular Bank, Bank of Cyprus	EUR 8.30 bn	Large depositors in Cyprus Popular Bank and Bank of Cyprus bailed-in in March 2013; EUR 8.3bn is the maximum possible contribution of depositors to recapitalization. Source: EC European Economy Occasional Papers 149
Denmark	2008 Oct	Roskilde Bank	DKK 2.47 bn	Roskilde Bank: Capital injections of DKK 750m and 1.72bn in October 2008 as a part of the process to liquidate Roskilde over the following years. Source: State aid NN 52/2010
Denmark	2009 Q2		DKK 35.00 bn	In February 2009, Bank Stabilization Package II passed and approved by the EC. Banks could apply for it until June 2009. Until June 2009, 11 institutions received DKK 35bn in Tier 1 capital, initially hybrid capital. On 17 August 2009 the EC approved that issuers can convert this hybrid capital into ordinary shares. Source: State aid scheme N31a/2009; State Aid N415/2009 and NN 46/2009
Denmark	2009 Q2	Fionia	DKK 0.79 bn	Fionia: New Fionia received DKK 790m capital injection (DKK 1bn approved by the EC on 20 May 2009 but not fully used). Source: State aid NN 23/2009; State aid N 560/2009
Denmark	2009 Q3		DKK 11.00 bn	Further capital injections from Bank Stabilization package. 43 credit institutions received DKK 46bn in the form of hybrid core capital (an increase of DKK 11bn from 2009 Q2). Source: IMF Country Report No. 13/23

Denmark	2010 Q4	Fionia	DKK 1.30 bn	Fionia: Nova Bank Fyn received a DKK 1.3bn capital injection (approved by the EC on 25 October 2010). Source: State aid N 560/2009; State aid SA 33117 (2011/N)
Denmark	2011 Jun	Eik Banki	DKK 3.48 bn	Eik Banki: Capital injections DKK 2bn (unit at Faroe Islands) and DKK 1.48bn (unit in Copenhagen), approved by the EC on 6 June 2011. Source: State aid SA.31945 (2011/NN)
Denmark	2012 Q2	Vestjysk Bank, Aarhus Lokalbank	DKK 0.17 bn	Capital injection of DKK 166.7m in the merger of Vestjysk Bank and Aarhus Lokalbank, approved in April 2012. Source: State aid SA.34423 (2012/N)
France	2008 Oct	Dexia	EUR 3.00 bn	Dexia: Capital injections of EUR 3bn by French state and state-owned CDC group and CNP Assurances in October 2008. (Dexia also received EUR 3bn of capital injections from Belgium and its regions, and Dexia's Luxembourg subsidiary EUR 376m from Luxembourg in the form of convertible bonds in October 2008.) Source: State aid C 9/2009 (ex NN 49/2008)
France	2008 Dec	BNP Paribas	EUR 2.55 bn	BNP Paribas: Injection of EUR 2.55bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. The EC approved up to EUR 21bn capital injections under the scheme on 8 December 2012. The first tranche of EUR 10.5bn was injected into 6 banks on implemented on 10 December 2008. Source: State aid N 613/2008; NYT: France Implements $13.6 Billion Bank Aid Plan (11 December 2008)
France	2008 Dec	Banque Populaire	EUR 0.95 bn	Banque Populaire: Injection of EUR 950m in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2008 Dec	Caisses d'Epargne	EUR 1.10 bn	Caisses d'Epargne: Injection of EUR 1.1bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2008 Dec	Credit Agricole	EUR 3.00 bn	Credit Agricole: Injection of EUR 3bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2008 Dec	Credit Mutuel	EUR 1.20 bn	Credit Mutuel: Injection of EUR 1.2bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2008 Dec	Societe Generale	EUR 1.70 bn	Societe Generale: Injection of EUR 1.7bn in hybrid instruments (TSS), qualifying as Tier 1 capital, by SPPE in December 2008. Source: State aid N 613/2008
France	2009 Q3	BPCE	EUR 5.00 bn	Merger of Banque Populaire and Caisses d'Epargne on 31 July 2009. The merged entity Groupe BPCE received EUR 2bn of super subordinated notes (TSS), issued to BP and CE by SPPE on 26 June 2009, and EUR 3bn preferred of stock injection on 31 July 2009. The most important subsidiary of BPCE is Natixis. Source: State Aid N 249/2009; BPCE Annual Report 2009

France	2012 Dec	Dexia	EUR 2.60 bn	Dexia: Capital injection by France EUR 2.6bn (and Belgium EUR 2.9bn) in December 2012. Source: IMF Country Report No. 13/124; Dexia Annual Report 2012
Germany	2008 Nov	Bayern LB	EUR 10.00 bn	Bayern LB: Capital injection of EUR 10bn from Bavaria in November 2008. Source: IMF Country Report No. 11/368
Germany	2008 Nov	Commerzbank	EUR 8.20 bn	Commerzbank: Capital injection of EUR 8.2bn by SoFFin in the form of silent participation in November 2008. Source: State aid SA.34539 (2012/N)
Germany	2009 Jan	Commerzbank	EUR 10.00 bn	Commerzbank: Additional capital injection of EUR 8.2bn in silent participation and EUR 1.8bn in ordinary shares in January 2009. Source: IMF Country Report No. 11/368; State aid SA.34539 (2012/N)
Germany	2009 Jan	HSH Nordbank	EUR 3.00 bn	HSH Nordbank: Capital injection of EUR 3bn in February 2009. Source: State aid C 29/2009 (ex N 503/2009)
Germany	2009 Mar	Hypo Real Estate	EUR 60 m	Hypo Real Estate: Capital injection of EUR 60m in March 2009. Source: State Aid 15/2009 (ex N 196/2009), N 333/2009 & N 557/2009
Germany	2009 Jun	Hypo Real Estate	EUR 2.96 bn	Hypo Real Estate: Capital injection of EUR 2.96bn in June 2009. Source: State Aid 15/2009 (ex N 196/2009), N 333/2009 & N 557/2009
Germany	2009 Jun	Landesbank Baden-Württenberg	EUR 5.00 bn	Landesbank Baden-Württenberg: Capital injection of EUR 5bn from state Baden-Württenberg in June 2009. Source: C/17/2009 (ex N265/2009)
Germany	2009 Oct	Hypo Real Estate	EUR 2.96 bn	Hypo Real Estate: Nationalization and a EUR 3bn capital injection in October. Source: State Aid 15/2009 (ex N 196/2009), N 333/2009 & N 557/2009
Germany	2009 Dec	West LB	EUR 3.00 bn	West LB: Winding-up institution created and a EUR 3bn capital injection in December 2009. Source: IMF Country Report No. 11/368; Staatliche Beihilfe C 40/2009
Germany	2010 May	Hypo Real Estate	EUR 1.85 bn	Hypo Real Estate: Capital injection of EUR 1.85bn in May 2010. Source: State Aid 15/2009 (ex N 196/2009), N 333/2009 & N 557/2009
Germany	2011 Jun	Hypo Real Estate	EUR 2.08 bn	Hypo Real Estate: Capital injection of EUR 2.08bn in June 2011. Source: State Aid 15/2009 (ex N 196/2009), N 333/2009 & N 557/2009
Germany	2011 Dec	Norddeutsche LB	EUR 1.67 bn	Norddeutsche LB: Capital increased by EUR 1,667m, approved by the EC on 22 December 2011. Source: State aid SA.33571 (2011/N); State aid SA.34381 (2012/N)
Germany	2012 Jul	Norddeutsche LB	EUR 1.00 bn	Norddeutsche LB: EUR 1bn additional recapitalization, approved by the EC on 25 July 2012. Source: State aid SA.34381 (2012/N)
Greece	2009 Q2		EUR 3.77 bn	Capital injections of EUR 3.769bn in May 2009 into 9 banks from Support Measures Scheme approved by the EC on 19 November 2008. Source: State Aid N 504/2009; State Aid N 260/2010
Greece	2011 Jun	ATE Bank	EUR 0.58 bn	ATE Bank (Agricultural Bank of Greece): Capital increase EUR 584.5m approved by the EC in May 2011, implemented until end of June 2011. Gross capital injection by the state EUR 1,144.5m of which EUR 675m used to repurchase shares from May 2009 recapitalization. Source: State aid N429/2010

Greece	2011 Oct	Proton Bank	EUR 0.25 bn	Proton Bank: Nea Proton Bank was created on 9 October 2011. It received EUR 250m capital injection from HFSF. Source: State aid SA.34488 (2012/C) (ex 2012 /NN)
Greece	2011 Nov	ATE Bank	EUR 0.29 bn	ATE Bank: Capital injection of EUR 290m in the form of capital rights in November 2011. Source: State Aid SA.35460 (2013/NN)
Greece	2011 Dec	National Bank of Greece	EUR 1.00 bn	National Bank of Greece: Capital injection of EUR 1bn approved by the EC on 22 December 2011. Source: State aid No SA.34824 (2012/C, ex 2012/NN)
Greece	2011 Dec	Piraeus Bank	EUR 0.38 bn	Piraeus Bank: Capital injection of EUR 380m approved by the EC on 28 December 2011. Source: State aid SA.34122 (2011/N)
Greece	2011 Dec	TT Helenic Postbank		TT Hellenic Postbank: In December 2011 T Bank was put into liquidation. EUR 2.16bn of its liabilities and EUR 1.483bn of assets were transferred to TT. TT was compensated for the funding gap of EUR 677m (not counted as recap). Source: State aid SA.31155 (2013/C) (2013/NN) (ex 2010/N);
Greece	2012 May	Alpha Bank	EUR 1.90 bn	Alpha Bank: Capital injection of EUR 1.9bn on 28 May 2012 by HFSF. Source: State aid No SA.34823 (2012/C, ex 2012/NN)
Greece	2012 May	EFG Eurobank	EUR 3.97 bn	EFG Eurobank: Capital injection of EUR 3.97bn on 28 May 2012 by HFSF. Source: State aid No SA.34825 (2012/C, ex 2012/NN)
Greece	2012 May	National Bank of Greece	EUR 7.43 bn	National Bank of Greece: Capital injection of EUR 7.43bn on 28 May 2012 by HFSF. Source: State aid No SA.34824 (2012/C, ex 2012/NN)
Greece	2012 May	Piraeus Bank	EUR 4.70 bn	Pireaus Bank: Capital injection of EUR 4.7bn on 28 May 2012. Source: State aid No SA.34826 (2012/C, ex 2012/NN)
Greece	2012 Jul	Piraeus Bank, ATE	EUR 0.57 bn	Piraeus Bank received EUR 7.471bn in EFSF bonds to cover the funding gap (not counted as recapitalization) in the purchase and assumption of ATE Bank and EUR 570m additional recapitalization related P&A of ATE by HFSF in July 2012. Source: State aid SA.35460 (2013/NN)
Greece	2013 Jan	TT Helenic Postbank	EUR 0.50 bn	TT Hellenic Postbank: Capital injection of EUR 500m into bridge bank New TT on 18 January 2013 in addition New TT received EUR 4.1bn from HFSF in the form of EFSF bonds to cover the funding gap from the transfer of assets from TT to New TT (not counted as recapitalization). Source: State aid SA.31155 (2013/C) (2013/NN) (ex 2010/N)
Hungary	2009 Apr	FHB	HUF 30.00 bn	FHB Mortgage bank: Capital injection of HUF 30bn in April 2009 (recapitalization approved by Hungarian authorities on 31 March 2009.) Source: IMF Country Report No. 10/80; State aid SA.29608 (C37/2010)
Iceland	2009 Sep	Arion	ISK 72.00 bn	Arion (Kaupthing) recapitalized with 72bn ISK in September 2009. Source: IMF Country Report No. 10/95
Iceland	2009 Sep	Islandbanki	ISK 65.00 bn	Islandbanki (Glitnir) recapitalized with ISK 65bn in September 2009. Source: IMF Country Report No. 10/96
Iceland	2009 Dec	Landsbankinn	ISK 150 bn	Landsbankinn recapitalized with ISK 150bn in December 2009. Source: IMF Country Report No. 10/95

Ireland	2009 Mar	Bank of Ireland	EUR 3.50 bn	Bank of Ireland: received a EUR 3.5bn injection of preferred stock in March 2009 (Announced in February, approved by the EC in March), EUR 1.67bn of it was converted into common stock in June 2010. Source: State aid SA.33216 (2011/N); State aid SA.33443 (2011/N)
Ireland	2009 May	Allied Irish	EUR 3.50 bn	Allied Irish Bank: Capital injection of EUR 3.5bn approved by the EC on 12 May 2009. Source: State aid SA.33296 (2011/N)
Ireland	2009 Jun	Anglo Irish	EUR 3.00 bn	Anglo Irish - first recapitalization: Capital injection of EUR 3bn in June 2009 (from EUR 4bn), the remaining EUR 1bn in two tranches in August and September 2009. Source: State aid NN12/2010 and C11/2010 (ex N667/2009)
Ireland	2009 Q3	Anglo Irish	EUR 1.00 bn	Anglo Irish: Capital injection of EUR 1bn in two tranches in August and September 2009 (second part of the EUR 4bn recap). Source: State aid NN12/2010 and C11/2010 (ex N667/2009)
Ireland	2010 Mar	INBS	EUR 2.70 bn	INBS (Irish Nationwide Building Society): Capital injection of EUR 2.7bn, approved by the EC on 30 March 2010 and implemented immediately. Source: State aid NN 50/2010 (ex N 441/2010)
Ireland	2010 May	Anglo Irish	EUR 10.30 bn	Anglo Irish - second recapitalization: Capital injection of EUR 8.3bn and EUR 2bn contingent capital, implemented in May 2010 (recapitalization up to EUR 10.44bn approved by the EC on 31 March 2010). Source: State aid NN 35/2010 (ex N 279/2010)
Ireland	2010 Jun	EBS	EUR 0.88 bn	EBS (Educational Building Society): Capital injection of EUR 875m (approved by the EC on 2 June 2010). Source: State aid N 160/2010
Ireland	2010 Aug	Anglo Irish	EUR 8.58 bn	Anglo Irish - third recapitalization: Capital injection of EUR 8.58bn (On 10 August 2010 the EC approved a recapitalization of EUR 10.054bn of which EUR 8.58bn was injected, the remaining EUR 1.474bn injected together with the fourth recapitalization). Source: State aid 32504 (2011/N) and C 11/2010 (ex N 667/2009)
Ireland	2010 Dec	Allied Irish	EUR 3.70 bn	Allied Irish Bank: Capital injection of EUR 3.7bn (EC approved a EUR 9.8bn capital injection, the first instalment of EUR 3.7bn was injected in December 2010; the second never took place). Source: State aid SA.33296 (2011/N)
Ireland	2010 Dec	Anglo Irish	EUR 6.42 bn	Anglo Irish - fourth recapitalization: Capital injection of EUR 1.474bn (remaining part from the third recapitalization and a EUR 4.946bn capital injection in December 2010. Source: State aid NN 35/2010 (ex N 279/2010); State aid SA.33296 (2011/N)
Ireland	2010 Dec	INBS	EUR 2.70 bn	INBS - second recapitalization: Capital injection of EUR 2.7bn (Approved by the EC on 21 December 2010). Source: State aid 32504 (2011/N) and C 11/2010 (ex N 667/2009)

Ireland	2011 Jul	Allied Irish & EBS	EUR 14.80 bn	Merger of Allied Irish Bank and EBS: EUR 14.8bn recapitalization provided to facilitate the merger (EUR 5bn by National Pensions Reserve Fund Commission, EUR 6.5bn by Ministry of Finance, EUR 1.6bn contingent capital, EUR 1.7bn from liability management exercises) in July 2011. Source: State aid SA.33296 (2011/N)
Ireland	2011 Jul	Bank of Ireland	EUR 5.30 bn	Bank of Ireland: EUR 200m state participation in a EUR 1.9bn rights issue and EUR 1bn injection of contingent capital in July 2011. Liability management exercises (conversion of liabilities into equity) contributed EUR 2.3-2.5bn of capital. Liability management exercises counted as recap. Private purchase of rights issue not. Source: State aid SA.33216 (2011/N); State aid SA.33443 (2011/N)
Ireland	2011 Jul	Irish Life & Permanent	EUR 2.70 bn	Irish Life & Permanent: Capital injection of EU 2.3bn in the form of ordinary shares and EUR 400m in contingent capital in July 2011. Source: State aid SA.33311 (2011/N)
Italy	2009 Jul	Gruppo Banco Popolare	EUR 1.45 bn	Gruppo Banco Popolare: Capital injection of EUR 1.45bn in the form of Tier 1 qualifying hybrid instruments in July 2009. Source: State aid N 425/2010
Italy	2009 Dec	Gruppo Banca Popolare Milano	EUR 0.50 bn	Gruppo Banca Popolare Milano: Capital injection of EUR 500m in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2011
Italy	2009 Dec	Gruppo Credito Valtellinese	EUR 0.20 bn	Gruppo Credito Valtellinese: Capital injection of EUR 200m in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2012
Italy	2009 Dec	Monte dei Paschi di Siena	EUR 1.90 bn	Monte dei Paschi di Siena: Capital injection of EUR 1.9bn in the form of Tier 1 qualifying hybrid instruments in December 2009. Source: State aid N 425/2013
Italy	2013 Jan	Monte dei Paschi di Siena	EUR 2.00 bn	Monte dei Paschi di Siena: Capital injection of EUR 3.9bn in the form of Tier 1 qualifying hybrid instruments. The recapitalization was approved by the EC on 17 December 2012 and implemented in January. EUR 1.9bn of the issue was used to replace the December 2009 recapitalization. Source: State aid SA.35137 (2012/N)
Kazakhstan	2009 Jan	Halyk Bank	USD 0.50 bn	Halyk Bank: Capital injection of USD 500m in January 2009. Source: IMF Country Report No. 10/237; EurasiaNet Kazakhstan: Astana Acts to Bolster Banks and Contain Rising Unemployment
Kazakhstan	2009 Jan	Kazkommertsbank	USD 0.30 bn	Kazkommertsbank: Capital injection of USD 300m in January 2009. Source: IMF Country Report No. 10/237; EurasiaNet Kazakhstan: Astana Acts to Bolster Banks and Contain Rising Unemployment
Kazakhstan	2009 Feb	Alliance	USD 0.20 bn	Alliance: Capital injection of USD 200m. Source: IMF Country Report No. 10/237; EurasiaNet Kazakhstan: With Financial System Stressed, Astana Takes Over Banks, Devalues Currency (3 February 2009)
Kazakhstan	2009 Feb	BTA	USD 1.70 bn	BTA: Capital injection of USD 1.7bn in February 2009. Source: IMF Country Report No. 10/237; EurasiaNet Kazakhstan: With Financial System Stressed, Astana Takes Over Banks, Devalues Currency (3 February 2009)

Latvia	2009 Jan	LHZB	LVL 30 m	Mortgage and Land Bank of Latvia (LHZB): Capital injection LVL 29.5m in January 2009. Source: State aid NN 60/2009
Latvia	2009 May	Parex	LVL 0.14 bn	Parex Banka: Nationalized in November 2008. In May 2009 it received a LVL 140.75 equity and LVL 50.27m subordinated debt qualifying as Tier 2 capital (Tier 2 capital instruments not counted as recapitalization). Source: State aid C 26/2009 (ex N 289/2009)
Latvia	2009 Nov	LHBZ	LVL 43 m	Mortgage and Land Bank of Latvia (LHBZ): Recapitalization by conversion of LVL 43.29m debt to state into equity, approved in November 2009. Source: State aid NN 60/2009; State aid 30704 (2012/C) (ex NN 53/2010)
Latvia	2010 Mar	LHBZ	LVL 70 m	Mortgage and Land Bank of Latvia (LHBZ): Capital injection LVL 70.2m on 23 March 2010. Source: State aid 30704 (2012/C) (ex NN 53/2010)
Latvia	2010 Sep	Parex Banka	LVL 0.31 bn	Parex Banka: Conversion of LVL 103m of State deposits into equity in Citadele banka (good bank created in splitting Parex) and conversion of LVL 210.7m deposits in Parex banka (bad bank), approved on 15 September 2010. Source: State aid C 26/2009 (ex N 289/2009)
Luxembourg	2008 Oct	Dexia	EUR 0.37 bn	Dexia: Luxembourg State invested EUR 376m of convertible bonds into Dexia's Luxemboug subsidiary in October 2008. Source: State Aid C 9/2009 (ex NN 45/2008)
Luxembourg	2008 Oct	Fortis Luxembourg	EUR 2.40 bn	Fortis Luxembourg: On 28 September 2008 Luxembourg government announced it will grant Fortis Luxembourg a convertible loan of EUR 2.5bn, later reduced to EUR 2.4bn. Source: State aid NN 46/2008
Luxembourg	2009 Oct	Fortis Luxembourg	EUR 0.10 bn	Fortis Luxembourg: On 28 September 2008 Luxembourg government announced it will grant Fortis Luxembourg a convertible loan of EUR 2.5bn, later reduced to EUR 2.4bn. The difference of EUR 100m was injected after approval of additional aid on 12 May 2009. Source: State aid N 274/2009
Mongolia	2010 Q2		MNT 100 bn	Recapitalization of a bank MNT 100bn in 2010. Month not known, assumed to be in 2010 Q2. Source: IMF Country Report No. 11/76
Netherlands	2008 Nov	ING	EUR 10.00 bn	ING: Capital injection of EUR 10bn approved on 12 November 2008. On 26 January 2009 ING entered into an a swap agreement under which the Netherlands receive 80% of cash flow from ING's Alt-A RMS portfolio; in exchange ING receives cash flows from a synthetic government bond portfolio (not counted as recapitalization). Source: State aid C 10/2009 (ex N 138/2009)
Netherlands	2008 Dec	SNS Reaal	EUR 0.75 bn	SNS Reaal: Capital injection of EUR 750m approved on 10 December 2008. Source: State aid N 611/2008

Netherlands	2009 Q3	ABN Amro	EUR 0.80 bn	ABN Amro: On October 3 2008 the Dutch government announced it purchased FBN, a subsidiary of Fortis with ABN Amro assets, for EUR 12.8bn and Fortis Insurance Netherlands for EUR 4bn (the purchase not counted as recapitalization). In July/August 2009 Dutch state provided a capital relief instrument in the form of a CDS having a capital relief effect of EUR 1.7bn (not counted as recapitalization) and mandatory convertible securities (MCS) in two tranches of EUR 500m and EUR 300m to ABN Amro Bank II NV (after separation from ABN Amro Bank NV on 6 February 2009 renamed into ABN Amro Bank; ABN Amro Bank renamed into Royal Bank of Scotland NV). Source: State aid NN 53/A/2008; State aid C 11/2009 (ex NN 53b/2008, NN 2/2010 and N 19/2010)
Netherlands	2010 Jan	ABN Amro	EUR 3.63 bn	ABN Amro: In January 2010 Dutch government notified the following capital measures: EUR 780m in the form of MCS to cover additional separation costs, EUR 300m in MCS to cover the capital shortfall from the sale of New HBU to Deutsche Bank, EUR 1.2bn in MCS to cover integration costs and EUR 1.35bn conversion of Tier 2 capital into Tier 1 capital. Source: State aid C 11/2009 (ex NN 53b/2008, NN 2/2010 and N 19/2010)
Netherlands	2013 Feb	SNS Reaal	EUR 2.70 bn	SNS Reaal: Nationalized on 1 February 2013. The state injected EUR 1.9bn of capital into SNS Bank and EUR 300m into SNS Reaal. In addition EUR 1bn of claims by shareholders and subordinated debt as well as EUR 0.8bn of equity injected by the State in December 2008 were written off (write-offs not counted as recapitalization). The State incurred also EUR 700m costs of isolating real estate portfolio (EUR 500m of these was a capital injection into a new real estate vehicle). Source: State aid SA.35382 (2013/N); Kamerbrief over de onteigening van SNS Reaal (Letter of Dutch Finance Ministry about Nationalisation of SNS Reaal)
Nigeria	2011 Aug	Afribank Plc, Bank PHB Plc, Springbank Plc	NGN 676 bn	Asset Management Corporation of Nigeria (AMCON) established in July 2010. Until May 2013 it acquired more than 12,000 problem loans, generally at market prices (based on IMF report and AMCON webpage). On 7 August 2011 AMCON took over three bridge banks from the Nigerian Deposit Insurance Corporation and announced a NGN 678bn recapitalization to bring their capital ratios to 15%. The bridge banks of the former Afribank Plc, Bank PHB Plc and Springbank Plc were to receive NGN 285bn, NGN 283bn and NGN 110bn respectively. Until then the banks have relied on central bank support. Source: IMF Country Report No. 13/140; Asset Management Corporation of Nigeria Act, 2010; This Day Live: AMCON Buys Afribank, Bank PHB, Spring Bank (http://www.thisdaylive.com/, 7 August 2011)
Portugal	2012 Feb	BPN	EUR 0.60 bn	BPN (Banco Português de Negócios): Nationalized in November 2008 at zero price; capital injection of EUR 600 in February 2012. Source: State Aid SA. 26909 (2011/C)

Portugal	2012 Jun	BCP	EUR 3.00 bn	Banco Comercial Português: Capital injection of EUR 3bn in the form of hybrid securities in June 2012 under the Portuguesse recapitalization scheme. Source: EC Press Release: State aid: Commission finalises discussions on restructuring plans for Portuguese banks CGD, Banco BPI, BCP (24 July 2013)
Portugal	2012 Jun	Banco BPI	EUR 1.50 bn	Banco BPI: Capital injection of EUR 1.5bn in the form of hybrid securities in June 2012 under the Portugesse recapitalization scheme. Source: EC Press Release: State aid: Commission finalises discussions on restructuring plans for Portuguese banks CGD, Banco BPI, BCP (24 July 2013)
Portugal	2012 Jun	CGD	EUR 1.65 bn	CGD (Caisa General de Depositos): Capital injection of EUR 750m in ordinary shares and EUR 900m in hybrid securities on 29 June 2012. Source: State aid SA.35062 (2012/NN)
Portugal	2013 Jan	Banif	EUR 1.10 bn	Banif (Banco Internacional do Funchal): Capital injection of EUR 1.1bn (EUR 700m in shares and EUR 400m in hybrid securities) in January 2013. Source: EC Press Release: State aid: Commission temporarily approves rescue recapitalisation of Portuguese bank Banif (21 January 2013)
Russia	2008 Q4	AMHL	RUB 60.00 bn	State Mortgage Agency: Capital injection of RUB 60bn in 2008, assumed to be Q4. Source: IMF Country Report No. 09/246
Russia	2008 Q4	VEB	RUB 75.00 bn	VEB (Vnesheconombank): Capital injection of RUB 75bn in 2008, assumed to be in Q4. Source: IMF Country Report No. 09/246
Russia	2009 Q2		RUB 70.00 bn	Total capital injections until 12 June 2009 were RUB 205bn. RUB 135bn had been injected in 2008. No data about any further recapitalizations. IMF Article IV Consultation from July 2010 says that the bank recapitalization plan was scrapped. The RUB 70bn difference between 2008 recapitalizations and total until June 2009 is assumed to have taken place in 2009 Q2. Source: IMF Country Report No. 09/246; IMF Country Report No. 10/246
Slovenia	2011 Mar	NLB	EUR 0.25 bn	Nova Ljubljanska Banka (NLB): Capital injection of EUR 250m in March 2011. Source: State aid SA. 34937 (2012/C) (ex 2012/N); IMF Country Report No. 11/121
Slovenia	2012 Jun	NLB	EUR 0.38 bn	Nova Ljubljanska Banka (NLB): Capital injection of EUR 320m in the form of CoCo bonds and EUR 63m in ordinary shares. Source: IMF Country Report No. 12/319
Slovenia	2012 Dec	NKBM	EUR 0.10 bn	Nova Kreditna Banka Maribor (NKBM): Capital injection of EUR 100m in the form of CoCo bonds in December 2012. Source: State aid SA.35709 (2012/N)
Slovenia	2013 Dec	Abanka	EUR 0.47 bn	Abanka: Capital injections of EUR 348m and bail-in of hybrid instruments of EUR 120m in order to insure financial stability before the final restructuring plan is prepared, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013); State aid n° SA.37690 (2013/N)

Slovenia	2013 Dec	Factor Banka	EUR 0.28 bn	Factor Banka: Capital injection of EUR 285m in the process of orderly winding down of the bank, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013)
Slovenia	2013 Dec	NKBM	EUR 0.87 bn	Nova Kreditna Banka Maribor (NKBM): Capital injection of EUR 870m, transfer of EUR 1.149bn (nominal amount) of bad assets to BAMC, an asset management company, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013)
Slovenia	2013 Dec	NLB	EUR 1.56 bn	Nova Ljubljanska Banka (NLB): Capital injection of EUR 1.558bn, transfer of EUR 2.3bn (nominal amount) of bad assets to BAMC, an asset management company, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013)
Slovenia	2013 Dec	Probanka	EUR 0.24 bn	Probanka: Capital injection of EUR 236m in the process of orderly winding down of the bank, approved by the EC and implemented in December 2013. Source: EC Press release: State aid: Commission approves rescue or restructuring for five Slovenian banks. (18 December, 2013)
Spain	2009 Apr	Caja Castilla-La Mancha	EUR 1.30 bn	CCM (Caja Castilla-La Mancha) received EUR 1.3bn injection of preference shares from FGD in April 2009. Source: State aid NN 61/2009
Spain	2010 Mar	Banco Ceiss	EUR 0.52 bn	Banco Ceiss: Convertible preference shares injection of EUR 525m in March 2010 by FROB. Source: State aid SA.34536 (2012/N)
Spain	2010 Mar	UNNIM	EUR 0.38 bn	UNNIM Banc: Convertible preference shares injection of EUR 380m in March 2010 by FROB (Fondo de Reestructuracio Ordenada Bancaria). Source: State aid SA.33095 (2011/N)
Spain	2010 Apr	Caixabank	EUR 0.98 bn	Caixabank: Convertible preference shares injection of EUR 0.977m in April 2010 by FROB. Source: Fondo de Reestructuracio Ordenada Bancaria (Slides from FROB webpage, April 2013)
Spain	2010 Jun	Banco Mare Nostrum	EUR 0.92 bn	Banco Mare Nostrum: Convertible preference shares injection of EUR 915m in June 2010 by FROB. Source: State aid SA.35488 (2012/N)
Spain	2010 Jun	Bankia-BFA	EUR 4.47 bn	Bankia-BFA: Convertible preference shares injection of EUR 4.465 m in June 2010 by FROB. Source: State aid SA.34820 (2012/N)
Spain	2010 Jun	NCG Banco	EUR 0.16 bn	NCG Banco (Novacaixagalicia): Convertible preference shares injection of EUR 162m in June 2010 by FROB. Source: State aid SA.33096 (2011/N)
+Spain	2011 Sep	NCG Banco	EUR 2.46 bn	NCG Banco (Novacaixagalicia): Injection of EUR 2,465m of ordinary shares by FROB in September 2011. Source: State aid SA.33734 (2012/N);
Spain	2011 Sep	UNNIM	EUR 0.57 bn	UNNIM Banc: Injection of EUR 568m of ordinary shares by FROB in September 2011. Source: State aid SA.33095 (2011/N)

Spain	2011 Q3	Catalunya Banc	EUR 2.97 bn	Catalunya Banc: Injections of ordinary shares by FROB: EUR 1,250m in July and EUR 1,718m in September 2011. Source: State aid SA.33103 (2011/N); State aid SA. 33735 (2012/N)
Spain	2011 Dec	Sabadell	EUR 5.25 bn	Sabadell received EUR 5,249m capital injection from the Deposit Guarantee Fund in December 2011. Source: Fondo de Reestructuracio Ordenada Bancaria (Slides from FROB webpage, April 2013)
Spain	2012 Jun	Banco de Valencia	EUR 1.00 bn	Banco de Valencia: Injection of EUR 1bn of ordinary shares by Frob in June 2012. Source: State aid SA.34053 (2012/N)
Spain	2012 Dec	Banco de Valencia	EUR 4.50 bn	Banco de Valencia: Injection of EUR 4.5bn of CoCo bonds by FROB, approved by the EC and implemented in December 2012. Source: State aid SA.34053 (2012/N)
Spain	2012 Dec	Bankia-BFA	EUR 17.96 bn	BFA-Bankia: Injection of EUR 17,959m of CoCo bonds by FROB, approved by the EC and implemented in December. Source: State aid SA.34820 (2012/N)
Spain	2012 Dec	Catalunya Banc	EUR 9.08 bn	Catalunya Banc: Injection of EUR 9,084m of CoCo bonds by FROB, approved by the EC and implemented in December 2012. Source: State aid SA. 33735 (2012/N)
Spain	2012 Dec	NCG Banco	EUR 5.43 bn	NCG Banco: Injection of EUR 5,425m of CoCo bonds by FROB, approved by the EC and implemented in December 2012. Source: State aid SA.33734 (2012/N)
Spain	2013 Mar	Banco Mare Nostrum	EUR 0.73 bn	Banco Mare Nostrum: Injection of EUR 730m of CoCo bonds by FROB, approved by the EC in December 2012, implemented in March 2013. Source: State aid SA.35488 (2012/N); FROB Press release - 12 March 2013
Spain	2013 Mar	Caja 3	EUR 0.41 bn	Caja 3: Injection of EUR 407m of CoCo bonds by FROB, approved by the EC in December 2012, implemented in March 2013. Source: State aid SA.35489 (2012/N); FROB Press release - 12 March 2013
Spain	2013 Mar	Liberbank	EUR 0.12 bn	Liberbank: Injection of EUR 124m of CoCo bonds by FROB, approved by the EC in December 2012, implemented in March 2013. Source: State aid SA.35490 (2012/N); FROB Press release - 12 March 2013
Spain	2013 Apr	Banco Ceiss	EUR 0.60 bn	Banco Ceiss: Injection of EUR 604m of CoCo bonds by FROB, approved by the EC in December 2012, implemented in April 2013. Source: State aid SA.36249 (2013/N); Eleconomista.es (26 April 2013)
Sweden	2009 Oct			Bank recapitalization scheme approved in October 2009 by the EC but no recapitalizations implemented. Source: State Aid N 69/2009; IMF Country Report No. 11/171
Switzerland	2008 Dec	UBS	SFR 6.00 bn	UBS: Capital injection of SFR 6bn in the form of mandatory convertible notes (MCN) on 9 December 2008. Source: IMF Country Report No. 09/164; UBS Annual Report 2008
Ukraine	2008 Q4	Oschadbank	UAH 13.70 bn	Oschadbank: Capital injection of UAH 13.7 in 2008 (assumed to be in Q4). Source: IMF Country Report No. 09/270; Oschadbank Annual Report 2008

Ukraine	2008 Q4	Ukreximbank	UAH 1.10 bn	Ukreximbank: Capital injection of UAH 100m in October and UAH 1bn in November 2008. Source: Ukreximbank further increases its authorized capital (www.eximb.com, 2 March 2009)
Ukraine	2009 Jan	Ukreximbank	UAH 3.70 bn	Ukreximbank: Capital injection of UAH 3.7bn in January 2009. Source: Ukreximbank shall further increase its authorized share capital through capitalisation of profits (www.eximb.com, 27 April 2009)
Ukraine	2009 Jul		UAH 9.47 bn	Capital injections of UAH 9.474 into Bank Kyiv, Rodovid Bank and Ukrgasbank in July 2009. Source: Kyiv Post: Recapitalization of three banks to be finished in days (7 July 2009)
Ukraine	2009 Q4		UAH 10.13 bn	According to IMF total bank recapitalizations in 2009 were UAH 23.3bn. The amount UAH 10.126bn is the difference between the total and the amounts known to be injected in specific banks. Source: IMF Country Report No.12/315
Ukraine	2010 Q1		UAH 6.40 bn	Bank recapitalizations in 2010 amounted to UAH 6.4bn. No data about precise timing, assumed to be in 2010 Q1. Source: IMF Country Report No.12/315
United Kingdom	2008 Oct	Royal Bank of Scotland	GBP 20.00 bn	Royal Bank of Scotland: Capital injection of GBP 15bn in ordinary shares and GBP 5bn in preference shares in October 2008. In January preference shares were converted into ordinary shares. Source: State aid No N 422/2009 and N 621/2009
United Kingdom	2009 Jan	Lloyds Banking Group	GBP 17.00 bn	Lloyds Banking Group: Capital injection of GBP 13bn in ordinary shares and GBP 4bn in preference shares, implemented on 20 January 2009. In June 2009 Lloyds issued GBP 4bn of ordinary shares to redeem the preference shares. GBP 1.7bn of these issue was bought by HM Treasury, which resulted in the total injection being reduced from GBP 17bn to GBP 14.7bn. Source: State aid No. N 428/2009
United Kingdom	2009 Dec	Royal Bank of Scotland	GBP 25.50 bn	Royal Bank of Scotland: Further capital injections of GBP 25.5bn in non-voting B shares, approved by EC in December 2009. In addition a five year contingent commitment of HM Treasury to inject GBP 8bn of B shares in case Core Tier 1 ratio falls below 5% was approved by EC and implemented in December 2009. Source: State aid No N 422/2009 and N 621/2009; RBS Annual Report 2009
United Kingdom	2009 Q4	Northern Rock	GBP 3.00 bn	Northern Rock: Nationalized in February 2008.In October 2009 the EC approved a split up of Northern Rock into BankCo, with retail deposits and unencumbered mortgage assets, and Asset Co with the remaining assets and liabilities. The EC approved a GBP 1.4bn recapitalization of BankCo in the form of ordinary shares and up to GBP 1.6bn recapitalization of AssetCo in the form of debt to equity conversion on 28 October 2009. Source: State Aid C 14/2008 (ex NN 1/2008)
United States	2008 Q4		USD 178 bn	TARP capital injections in 2008 Q4. Source: Troubled Asset Relief Program Transactions Report - Investment Programs For Period Ending January 16, 2013
United States	2009 Q1		USD 21.25 bn	TARP capital injections in 2009 Q1. Source: Troubled Asset Relief Program Transactions Report - Investment Programs For Period Ending January 16, 2013

United States	2009 Q2	USD 4.43 bn	TARP capital injections in 2009 Q2. Source: Troubled Asset Relief Program Transactions Report - Investment Programs For Period Ending January 16, 2013
United States	2009 Q3	USD 1.42 bn	TARP capital injections in 2009 Q3. Source: Troubled Asset Relief Program Transactions Report - Investment Programs For Period Ending January 16, 2013
United States	2009 Q4	USD 0.28 bn	TARP capital injections in 2009 Q4. Source: Troubled Asset Relief Program Transactions Report - Investment Programs For Period Ending January 16, 2013

Table A2: Bank recapitalizations in systemic banking crises in the period 1980-2007.

For explanation on how the dataset is constructed see Chapter 3, Section 3.5.2.

Country	Date	Recapitalization	Description
Bolivia	1996 Sep		FONDESIF restructuring fund established in September 1995. FONDESIF provided subordinated debt and medium-term loans to banks that have submitted a statement of financial position in accordance with Basel rules. Three of four banks were restructured in the first half of 1996. Source: IMF Staff Country Report No. 97/99
Brazil	1996 Jun	BRL 6.40 bn	Banco do Brasil: recapitalization of BRL 8.3bn of which BRL 6.4bn contributed by the government. Source: IMF Staff Country Report No. 98/24
Bulgaria	1995 May	USD 80 m	Mineral Bank, Economic Bank: Zunk bonds (long term government bonds trading at discount) that the two banks held were converted at face value into short term government bonds having a recapitalization effect of USD 80m. Source: IMF Staff Country Report No. 99/26
Bulgaria	1996 Q2	USD 0.18 bn	Recapitalization of 7 state owned banks by giving them $180m worth of Zunk bonds without quid pro quo. Source: IMF Staff Country Report No. 99/26
Bulgaria	1997 Apr	USD 50 m	A state-owned bank was recapitalized with USD 50m. Source: IMF Staff Country Report No. 99/26
Colombia	1999 Q2	COP 250 bn	In May 2009 the government announced a recapitalization plan under which bank resolution agency FOGAFIN lent to bank shareholders who then recapitalized banks. Bank shareholders had to provide at least 20% of recapitalization funds on their own. The participating institutions had to write-off impaired assets and accept FOGAFIN covenants. Bank shareholders had to provide at least 20% of recapitalization funds. The total amount of recapitalizations until September 1999 was COP 500bn of which FOGAFIN provided COP 350bn. It is assumed that half of the amount was injected in 1999 Q2 and half in Q3. Source: IMF Staff Country Report No. 99/149
Colombia	1999 Q3	COP 250 bn	See Colombia 1999 Q2. Source: IMF Staff Country Report No. 99/149
Croatia	1998 Q4	HRK 0.60 bn	A banking law that enabled more timely intervention approved in December 1998. Cash injections in 1998 amounted to HRK 0.6bn and HRK 1.2bn in 2009. Cash injections presumably refer to recapitalizations and to facilitation of mergers of distressed banks with solvent institutions. (Government issued HRK 0.6bn of bonds to fund bank resolution in 1998 and HRK 2.1bn in 2009.) The allocation across quarters is as follows: The 2008 amount is assumed to have taken place only in 2008 Q4; the 2009 amount is spread equally across 1999 Q1-Q4. Source: IMF Staff Country Report No. 00/22
Croatia	1999 Q1	HRK 0.30 bn	See Croatia 1998 Q4. Source: IMF Staff Country Report No. 00/22
Croatia	1999 Q2	HRK 1.30 bn	See Croatia 1998 Q4. Source: IMF Staff Country Report No. 00/22
Croatia	1999 Q3	HRK 2.30 bn	See Croatia 1998 Q4. Source: IMF Staff Country Report No. 00/22
Croatia	1999 Q4	HRK 3.30 bn	See Croatia 1998 Q4. Source: IMF Staff Country Report No. 00/22

Czech Republic	1996 Q4		Bank restructuring in Czech Republic was done in three rounds. Consolidation program I in 1991-1993 was focused on large stat-owned banks. CZK 8bn was injected as recapitalizations and CZK 22bn was used for purchases of bad assets. Consolidation program II focused on small and medium-sized banks started at the end of 1995. 18 banks were selected for the program. Of these 9 were recapitalized by private investors and 5 were placed under forced administration and 2 were liquidated. The total cost of the program was CZK 30bn. Breakdown is not available. In October 1996 the third program started. Government purchased troubled assets at face value. Banks were required to buy them back in 5-7 years. This was a long term interest-free repurchase agreement. In total CZK 14bn was extended to banks under this stabilisation program. The first two programs are before the start of the banking crisis. The third program had an effect similar to recapitalizations but there is no estimate of the subsidy received by the banks participating in the program. Source: IMF Staff Country Report No. 98/36
Ecuador	1999 Q3	USD 0.41 bn	After the results of international audits of bank capital deficiency were announced on 30 July 1999 banks with insufficient capital were recapitalized and deeply insolvent ones were taken over by AGD (Deposit insurance agency) to be resolved. Although international best practices were not strictly followed and estimates of capital deficiency were to low the measures helped temporarily restore public confidence. AGD issued USD 1.4bn of bonds to fund recapitalizations provide liquidity assistance to banks that it took over, pay deposit guarantees and for credit lines. Laeven & Valencia report that USD 320m was injected in Filanbanco and USD 100m in CFN. Source: IMF Staff Country Report No, 00/125; Laeven & Valencia (2012) Database
Finland	1992 Q2	FMK 4.67 bn	In 1992 the Council of State injected FMK 7,912m into 9 banks. In addition Government guarantee fund (GGF) injected FMK 2,200m in the form of preferred capital certificates and FMK 3,900m in ordinary shares. GGF was established in April 1992. It is assumed that intervention is equally distributed across 1992 Q2- Q4. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1992 Q3	FMK 4.67 bn	See Finland 1992 Q2. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1992 Q4	FMK 4.67 bn	See Finland 1992 Q2. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1993 Q1	FMK 1.65 bn	In 1993 Council of State injected FMK 1bn in the form of preferred capital certificates and FMK 250m in share capital. GGF injected FMK 5,186m in the form of preferred capital certificates and FMK 150m in share capital. It is assumed that intervention is equally distributed across 1993 Q1 - Q4. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1993 Q2	FMK 1.65 bn	See Finland 1993 Q1. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1993 Q3	FMK 1.65 bn	See Finland 1993 Q1. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Finland	1993 Q4	FMK 1.65 bn	See Finland 1993 Q1. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Indonesia	1999 May	IDR 104 tn	Bank recapitalizations were accompanied by improvements in management, new business plans and operational restructuring. Recapitalization amounts are based on the data about bonds issued in 1999 and 2000 to fund bank restructuring, excluding the amounts to cover the losses of the central bank. In May 1999, IDR 103.8 tn of such bonds were issued. Source: IMF Staff Country Report No, 00/132
Indonesia	1999 Oct	IDR 103 tn	In October 1999, IDR 103tn of bonds for bank restructuring were issued. See also description of Indonesia in May 1999. Source: IMF Staff Country Report No, 00/132
Indonesia	1999 Dec	IDR 75 tn	In December 1999, IDR 75tr of bonds for bank restructuring were issued. See also description of Indonesia in May 1999. Source: IMF Staff Country Report No, 00/132

Indonesia	2000 Apr	IDR 30 tn	In April 2000 IDR, 30tr of bonds for bank restructuring were issued. See also description of Indonesia in May 1999. Source: IMF Staff Country Report No, 00/132
Indonesia	2000 Jun	IDR 70 tn	In June 2000, IDR 70.1tr of bonds for bank restructuring were issued. See also description of Indonesia in May 1999. Source: IMF Staff Country Report No, 00/132
Indonesia	2000 Jul	IDR 30 tn	In July 2000, IDR 30.2tr of bonds for bank restructuring were issued. See also description of Indonesia in May 1999. Source: IMF Staff Country Report No, 00/132
Jamaica	1997 Q1	JMD 0.73 bn	FINSAC restructuring fund established in January 2007. Cash injections of FINSAC until April 1998 amounted to JMD 2.2b. It is assumed that recapitalization amounts are evenly distributed across the quarters in which FINSAC acquired banks (1997 Q1, 1997 Q2 and 198 Q1). Source: IMF Staff Country Report No. 99/2
Jamaica	1997 Q2	JMD 0.73 bn	See Jamaica 1997 Q2, Source: IMF Staff Country Report No. 99/2
Jamaica	1998 Q1	JMD 0.73 bn	See Jamaica 1997 Q2, Source: IMF Staff Country Report No. 99/2
Japan	1998 Mar	JPY 1,875 bn	Capital injections into banks in March 1998 were one quarter of capital injections next year when JPY 7.5tr was injected in March 1999. Source: IMF Staff Country Report No. 99/83
Japan	1999 Mar	JPY 7,500 bn	Capital injections into banks in March 1999 amounted to JPY 7.5tr. Source: IMF Staff Country Report No. 99/83
Korea	1998 Q1	KRW 3,320 bn	In January 1998 two large commercial banks (Korea First Bank and Seoul Bank) were taken over by the government. In July 1998 purchase and assumption deals for 5 small banks were arranged. Additional mergers took place in January, April and September 1999 and two banks were recapitalized in 1999. The total amount of recapitalizations was KRW 16.6bn. The amounts are assumed to be evenly spread across quarters in which there was intervention. Source: IMF Staff Country Report No. 00/11
Korea	1998 Q3	KRW 3,320 bn	See Korea 1998 Q1. Source: IMF Staff Country Report No. 00/11
Korea	1999 Q1	KRW 3,320 bn	See Korea 1998 Q1. Source: IMF Staff Country Report No. 00/11
Korea	1999 Q2	KRW 3,320 bn	See Korea 1998 Q1. Source: IMF Staff Country Report No. 00/11
Korea	1999 Q3	KRW 3,320 bn	See Korea 1998 Q1. Source: IMF Staff Country Report No. 00/11
Latvia	1995 Q3	LVL 40 m	Latvian Savings Bank recapitalized with 40m LVL. Date not known, assumed to be in 1995 Q3 since the crisis started in April 1995 and the IMF report from December 1995 says that the bank was still undercapitalized after the intervention. Source: IMF Staff Country Report No. 95/125
Malaysia	1998 Q3	IDR 1.54 bn	Danamodal (bank recapitalization fund) was set up in mid-1998. The total amount injected until May 1999 was IDR 6,159m. The amounts are assumed to be equally distributed across 1998 Q3 - 1999 Q2 Source: IMF Staff Country Report No. 99/86
Malaysia	1998 Q4	IDR 1.54 bn	See Malaysia 1998 Q3. Source: IMF Staff Country Report No. 99/87
Malaysia	1999 Q1	IDR 1.54 bn	See Malaysia 1998 Q3. Source: IMF Staff Country Report No. 99/88
Malaysia	1999 Q2	IDR 1.54 bn	See Malaysia 1998 Q3. Source: IMF Staff Country Report No. 99/89
Mexico	1995 Q2	USD 2.33 bn	Bank restructuring program PROCAPTE implemented in March 1995; 7bn spent for PROCAPTE in 1995. Source: Laeven & Valencia (2012) Database
Mexico	1995 Q3	USD 2.33 bn	See Mexico 1995 Q2. Source: Laeven & Valencia (2012) Database
Mexico	1995 Q4	USD 2.33 bn	See Mexico 1995 Q2. Source: Laeven & Valencia (2012) Database
Norway	1991 Aug	NOK 4.90 bn	Commercial Bank's Guarantee Fund (CBGF) injected NOK 2,150m equity in Fokus Bank and NOK 2,725m in Christiana Bank in August 1991 and NOK 22m in other commercial banks. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?

Norway	1991 Q4	NOK 6.74 bn	Savings Bank's Guarantee Fund injected NOK 525m equity into Sparebanken Midt-Norge and NOK 600m in Sparebanken Rogaland in October 1991. In November 1991 Government Bank Insurance Fund injected NOK 475m in Fokus Bank and NOK 5,140m in Christiana Bank. In addition Government Bank Investment Fund was set up that participated in capital issues by banks on commercial terms together with private investors. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Norway	1992 Q1	NOK 7.47 bn	In 1992 Savings Bank's Guarantee Fund injected NOK 75m into Sparebanken Midt-Norge and NOK 144m into Sparebanken Rogaland. Government Bank Insurance Fund injected NOK 4,750m into Den Norske Bank and NOK 1,900m into Sparebanken Midt-Norge and NOK 600m into Sparebanken Rogaland. No data in which month these injections took place, presumably in 1992 Q1 since all these banks have already received some support in 1991 Q4 and their problems continued. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Sweden	1991 Q4	SEK 4.20 bn	Nordbanken: The state bought SEK 4.2bn of SEK 5.2bn of equity issued by Nordbanken in Autumn 1991. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Sweden	1992 Q2	SEK 34.00 bn	Nordbanken split into a good and bad bank. Securum (bad bank) received SEK 24bn capital injection and Nordbanken received SEK 10bn in equity capital in spring 1992. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Sweden	1993 Q2	SEK 23.80 bn	Bank Support Authority established in May 1993. Gota bank received SEK 20bn, Retriva (bad bank of Gota bank) SEK 3.8bn. The amount received by S-E Banken and Foringsbanken not know. Source: IMF Working Paper 95/61: The Nordic Crises: Pitfalls in Financial Liberalization?
Thailand	1996 Q1	USD 1.61 bn	In March 1996 Bangkok Bank of Commerce was intervened. The total amount of recapitalizations until February 2000 was USD 12bn. Of these recapitalization of Sciam Commercial bank was USD 0.75bn. For other banks dates when they were intervened are available but not the amounts injected into each bank. The amounts are allocated across quarters assuming that all 7 intervened banks received equal amounts. Source: IMF Staff Country Report No. 00/21
Thailand	1997 Q4	USD 1.61 bn	In December 1997 Bangkok Metropolitan Bank was intervened. See also description of Thailand 1996 Q1. Source: IMF Staff Country Report No. 00/22
Thailand	1998 Q1	USD 3.21 bn	In January 1998 First Bangkok City Bank and Siam City Bank were intervened. See also description of Thailand 1996 Q1. Source: IMF Staff Country Report No. 00/23
Thailand	1998 Q3	USD 3.21 bn	In August 1998 Union Bank Bangkok and Laem Thong Bank were intervened. See also description of Thailand 1996 Q1. Source: IMF Staff Country Report No. 00/24
Thailand	1999 Q2	USD 0.75 bn	Sciam Commercial Bank raises USD 1.5bn of new capital, half of it from the support scheme. Source: IMF Staff Country Report No. 00/25
Thailand	1999 Q3	USD 1.61 bn	In July 1999 Nakornthon Bank was intervened. See also description of Thailand 1996 Q1. Source: IMF Staff Country Report No. 00/26
Turkey	2002 Q2	USD 1.90 bn	Pamuk Bank intervened by BRSA (Bank Regulation and Supervision Authority) in June 2002. Amount of recapitalization not explicitly mentioned. The reference is only to USD 1.9bn capital shortfall of Pamuk Bank. Source: IMF Country Report No. 02/229
Turkey	2002 Q3	USD 0.20 bn	In June 2002 audits of bank capital deficiency were completed. Capital shortfall at the end of 2001 was TRY 1,326tr (approximately USD 1bn). Until June banks have already raised USD 0.8bn. The remainder was expected to be injected from the recapitalization scheme. Source: IMF Country Report No. 02/229

Uruguay	2002 Q3	USD 33 m	Capital injection of USD 33m into one commercial bank. Assumed to be in 2002 Q3 since the amounts are reported as of August 2002 and the banking crisis started in January 2002. Source: IMF Country Report No. 03/247; Laeven & Valencia (2012) Database
Uruguay	2003 Q2	USD 4 m	In March 2003 a new bank Nuevo Banco Comercial was created to acquire to manage the assets of three liquidated banks. The assets were transferred using purchase and assumption approach. The state has provide USD 4bn new capital. Source: IMF Country Report No. 03/247
Venezuela	1994 Q2	VEB 0.48 bn	During 1994 13 out of 47 were closed or nationalized. The total support to banking sector and payments to depositors were USD 8.6bn (13% of GDP) in 1994 and USD 3.1bn (4% of GDP) in 1995. According to Laeven and Valencia (2012) database capital injections by FOGADE (deposit insurance fund) amounted to 5.59% of GDP in 1994. This is VEB 484m. Precise date is not known, assumed to be in 1994 Q2. Source: IMF Staff Country Report No. 96/87
Vietnam	1998 Q4	VND 2,400 bn	In October 1998 State Bank recapitalized four state-owned commercial banks by converting VND 2.4tr of loans into equity. Source: IMF Staff Country Report No. 99/55

Bibliography

Acharya, V. V, I. Drechsler, and P. Schnabl. 2014. A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk. *Journal of Finance* LXIX:2689–2739.

Acharya, V. V, T. Eisert, C. Eufinger, and C. Hirsch. 2014. Real Effects of the Sovereign Debt Crisis in Europe: Evidence from Syndicated Loans. *Working paper* .

Acharya, V. V, R. Engle, and M. Richardson. 2012. Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks. *American Economic Review* 102:59–64.

Acharya, V. V, and S. Steffen. 2014a. Benchmarking the European Central Bank's Asset Quality Review and Stress Test: A Tale of Two Leverage Ratios. *VOX CEPR's Policy Portal* .

Acharya, V. V, and S. Steffen. 2014b. Making Sense of the Comprehensive Assesment. *Working paper* October 27.

Acharya, V. V, and S. Steffen. 2014c. Falling Short of Expectations ? Stress-Testing the European Banking System. *CEPS Policy Brief* 315.

Acharya, V. V, and T. Yorulmazer. 2007. Too Many to fail—An Analysis of Time-Inconsistency in Bank Closure Policies. *Journal of Financial Intermediation* 16:1–31.

Admati, A. R., P. M. Demarzo, M. F. Hellwig, and P. Pfleiderer. 2013. Fallacies, Irrelevant Facts, and Myths in the Discussion of Capital Regulation: Why Bank Equity Is Not Socially Expensive. *Working Paper* .

Admati, A. R., P. M. DeMarzo, M. F. Hellwig, and P. C. Pfleiderer. 2013. The Leverage Ratchet Effect. *Working paper, Stanford University* .

Adrian, T., and M. K. Brunnermeier. 2014. CoVar. *Working paper* :1–51.

Aghion, P., P. Bolton, and S. Fries. 1999. Optimal Design of Bank Bailouts: The Case of Transition Economies. *Journal of Institutional and Theoretical Economics* 155:51–70.

Alfaro, R., and M. Drehmann. 2009. Macro Stress Tests and Crises: What Can We Learn? *BIS Quarterly Review* :29–42.

Allen, F., E. Carletti, and R. Marquez. 2009. Credit Market Competition and Capital Regulation. *Review of Financial Studies* 24:983–1018.

Allen, F., and D. Gale. 2000. Financial Contagion. *Journal of Political Economics* 108:1–33.

Andrade, P., C. Cahn, H. Fraisse, and J. S. Mesonnier. 2015. Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's LTRO. *Banque de France Working paper* .

Asness, C., and A. Frazzini. 2013. The Devil in HML's Details. *Journal of Portfolio Management* .

Baba, N. 1996. Empirical Studies on the Recent Decline in Bank Lending Growth: An Approach Based on Asymetric Information. *IMES Discussion Paper 96-E-10* .

Bank of England. 2011. Credit Risks to the UK Banking System. *Financial Stability Report* .

Bank of England. 2013. SME Forbearance and Its Implications for Monetary and Financial Stability. *Quarterly Bulletin 2013 Q$* :296–303.

Barth, J. R., G. Caprio, and R. Levine. 2012. The Evolution and Impact of Bank Regulations. *World Bank Policy Research Working Paper 6288* :1–27.

Beck, R., P. Jakubik, and A. Piloiu. 2013. Non-Performing Loans: What Matters in Addition to the Economic Cycle. *ECB Working Paper Series* .

Beck, T., R. Todorov, and W. Wagner. 2012. Supervising Cross-Border Banks: Theory, Evidence and Policy. *Working paper* .

Berger, A. N., C. H. S. Bouwman, T. Kick, and K. Schaeck. 2014. Bank Risk Taking and Liquidity Creation Following Regulatory Interventions and Capital Support. *Working paper* .

Berger, A. N., and R. A. Roman. 2013. Did TARP Banks Get Competitive Advantages? *Working paper* :0–55.

Berger, A. N., and R. A. Roman. 2015. Did Saving Wall Street Really Save Main Street? The Real Effects of TARP on Local Economic Conditions. *Working paper* April 2015.

Berglof, E., and G. Roland. 1995. Bank Restructuring and Soft Budget Constraints in Financial Transition. *Journal of the Japanese and International Economies* 9:354–75.

Black, L. K., and L. N. Hazelwood. 2013. The Effect of TARP on Bank Risk-Taking. *Journal of Financial Stability* 9:790–803.

Boot, A. W. A., and A. V. Thakor. 1993. Self-Interested Bank Regulation. *The American Economic Review* 83:206–12.

Borio, C., M. Drehmann, and K. Tsatsaronis. 2014. Stress-Testing Macro Stress Testing: Does It Live up to Expectations? *Journal of Financial Stability* 12:3–15.

Brown, C. O., and I. S. Dinc. 2009. Too Many to Fail? Evidence of Regulatory Forbearance When the Banking Sector Is Weak. *Review of Financial Studies* 24:1378–1405.

Bruche, M., and G. Llobet. 2014. Preventing Zombie Lending. *Review of Financial Studies* 27:923–56.

Caballero, R. J., T. Hoshi, and A. K. Kashyap. 2008. Zombie Lending and Depressed Restructuring in Japan. *American Economic Review* 98:1943–77.

Calomiris, C. W., and R. J. Herring. 2013. How to Design a Contingent Convertible Debt Requirement That Helps Solve Our Too-Big-to-Fail Problem. *Journal of Applied Corporate Finance* 25:20–44.

Calomiris, C. W., J. R. Mason, M. Weidenmier, and K. Bobroff. 2013. The Effects of Reconstruction Finance Corporation Assistance on Michigan's Banks' Survival in the 1930s. *Explorations in Economic History* 50:526–47.

Carhart, M. M. 1997. On Persistence in Mutual Fund Performance. *Journal of Finance* LII:57–82.

Chan, S., and S. J. G. van Wijnbergen. 2014. Cocos, Contagion and Systemic Risk. *Tinbergen Institute Discussion Paper* TI 14-110:1–49.

Charumilind, C., R. Kali, and Y. Wiwattanakantang. 2006. Connected Lending: Thailand before the Financial Crisis. *Journal of Business* 79:181–218.

Chodorow-Reich, G. 2014. The Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008-9 Financial Crisis. *Quarterly Journal of Economics* 129:1–59.

Claessens, S., D. Klingebiel, and L. Laeven. 2005. Crisis Resolution, Policies, and Institutions: Empirical Evidence. In Honohan, P. and L. Laeven (eds.), *Systemic Financial Distress: Containment and Resolution*. Cambridge: Cambridge University Press.

Cornett, M. M., J. J. McNutt, P. E. Strahan, and H. Tehranian. 2011. Liquidity Risk Management and Credit Supply in the Financial Crisis. *Journal of Financial Economics* 101:297–312.

Damar, E., R. Gropp, and A. Mordel. 2012. The Ex-Ante Versus Ex-Post Effect of Public Guarantees. *Bank of Canada Working paper 2012-22* .

Dell'Ariccia, G., E. Detragiache, and R. G. Rajan. 2008. The Real Effect of Banking Crises. *Journal of Financial Intermediation* 17:89–112.

Dell'Ariccia, G., L. Laeven, and R. Marquez. 2014. Real Interest Rates, Leverage, and Bank Risk-Taking. *Journal of Economic Theory* 149:65–99.

Dell'Ariccia, G., L. Laeven, and G. Suarez. 2013. Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States. *IMF Working paper* 12/143.

Dell'Ariccia, G., and R. Marquez. 2006. Lending Booms and Lending Standards. *Journal of Finance* LXI:2511–46.

Demirguc-Kunt, A., and E. Detragiache. 2002. Does Deposit Insurance Increase Banking System Stability? An Empirical Investigation. *Journal of Monetary Economics* 49:1373–1406.

Diamond, D. W. 2001. Should Banks Be Recapitalized? *Federal Reserve Bank of Richmond Economic Quarterly* 87:71–96.

Diamond, D. W., and R. G. Rajan. 2000. A Theory of Bank Capital. *Journal of Finance* LV:2431–65.

Diamond, D. W., and R. G. Rajan. 2011. Fear of Fire Sales, Illiquidity Seeking, and Credit Freezes. *The Quarterly Journal of Economics* 126:557–91.

Driscoll, J. C., and A. C. Kraay. 1998. Consistent Covariance Matrix Estimation With Spatially Dependent Panel Data. *Review of Economics and Statistics* 80:549–60.

Duchin, R., and D. Sosyura. 2014. Safer Ratios, Riskier Portfolios: Banks′ Response to Government Aid. *Journal of Financial Economics* 113:1–28.

EBA. 2014. EBA Final Draft Implementing Technical Standards on Supervisory Reporting on Forbearance and Non-Performing Exposures under Article 99 (4) of Regulation (EU) No 575/2013. EBA/ITS/20.

ECB. 2014a. Aggregate Report on the Comprehensive Assessment. *European Central Bank* October 20.

ECB. 2014b. *Asset Quality Review - Phase 2 Manual*. .

Eisfeldt, A. L., and A. a. Rampini. 2008. Managerial Incentives, Capital Reallocation, and the Business Cycle. *Journal of Financial Economics* 87:177–99.

ESRB. 2012. Reports of the Advisory Scientific Committee. *Reports of the Advisory Scientific Committee* 2012:1–26.

ESRB. 2014. EBA/SSM Stress Test: The Macroeconomic Adverse Scenario.:1–17.

European Commission. 2015. Regulation (EU) 2015/227.

Fama, E. F., and K. R. French. 1993. Common Risk Factors in the Returns on Stocks and Bonds. *Journal of Financial Economics* 33:3–56.

Farhi, E., and J. Tirole. 2012. Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts. *American Economic Review* 102:60–93.

Galati, G., and R. Moessner. 2012. Macroprudential Policy - a Literature Review. *Journal of Economic Surveys* 27:846–78.

Gennaioli, B. N., A. Shleifer, and R. Vishny. 2015. Neglected Risks: The Psychology of Financial Crises. *American Economic Review* 105:310–14.

Giannetti, M., and A. Simonov. 2013. On the Real Effects of Bank Bailouts: Micro Evidence from Japan. *American Economic Journal: Macroeconomics* 5:135–67.

Górnicka, L. A. 2014. Shadow Banking and Traditional Bank Lending: The Role of Implicit Guarantees. *Working paper* :1–47.

Gorton, G., and A. Metrick. 2010. Regulating the Shadow Banking System. *Brooking Papers on Economic Activity* :261–312.

Gropp, R., C. Gruendl, and A. Guettler. 2013. The Impact of Public Guarantees on Bank Risk-Taking: Evidence from a Natural Experiment. *Review of Finance* :1–32.

Gropp, R., H. Hakenes, and I. Schnabel. 2011. Competition, Risk-Shifting, and Public Bail-out Policies. *Review of Financial Studies* 24:2084–2120.

Hanson, S. G., A. K. Kashyap, and J. C. Stein. 2011. A Macroprudential Approach to Financial Regulation. *Journal of Economic Perspectives* 25:3–28.

Hellmann, T. F., K. C. Murdock, and J. E. Stiglitz. 2000. Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough? *American Economic Review* 90:147–65.

Hoechle, D. 2007. Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. *Stata Journal* :1–31.

Hoggarth, G., R. Reis, and V. Saporta. 2002. Costs of Banking System Instability: Some Empirical Evidence. *Journal of Banking and Finance* 26:825–55.

Homar, T., and S. J. G. van Wijnbergen. 2014. On Zombie Banks and Recessions after Systemic Banking Crises: Government Intervention Matters. *Working paper* :1–52.

Honohan, P., and D. Klingebiel. 2003. The Fiscal Cost Implications of an Accommodating Approach to Banking Crises. *Journal of Banking and Finance* 27:1539–60.

Huizinga, H., and L. Laeven. 2012. Bank Valuation and Accounting Discretion during a Financial Crisis. *Journal of Financial Economics* 106:614–34.

IAS 39. 2011. International Accounting Standard 39 Financial Instruments: Recognition and Measurement.:1–61.

IMF. 2013a. World Economic Outlook Database.

IMF. 2013b. Internatioal Financial Statistics Database.

Ioannidou, V., S. Ongena, and J.-L. Peydro. 2014. Monetary Policy, Risk-Taking, and Pricing: Evidence from a Quasi-Natural Experiment. *Review of Finance* 19:95–144.

Ivashina, V., and D. Scharfstein. 2010. Bank Lending during the Financial Crisis of 2008. *Journal of Financial Economics* 97:319–38.

Jimenez, G., S. Ongena, J. L. Peydro, and J. Saurina. 2012. Credit Supply and Monetary Policy: Identifying the Bank-Balance Sheet Channel with Loan Applications. *American Economic Review* 102:2301–26.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina Salas. 2014. Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments. *Working Paper* September.

Johnson, S., and T. Mitton. 2003. Cronyism and Capital Controls: Evidence from Malaysia. *Journal of Financial Economics* 67:351–82.

Kearns, A. 2004. Loan Losses and the Macroeconomy: A Framework for Stress Testing Credit Institutions' Financial Well-Being. *Financial Stability Report* :111–22.

Kok, C., and G. Schepens. 2013. Bank Reactions after Capital Shortfalls. *European Central Bank Working Paper Series* 1611:1–34.

Kroszner, R., L. Laeven, and D. Klingebiel. 2007. Banking Crises, Financial Dependence, and Growth. *Journal of Financial Economics* 84:187–228.

Kwaak, C. G. F. van der, and S. J. G. van Wijnbergen. 2014. Financial Fragility, Sovereign Default Risk and the Limits to Commercial Bank Bail-Outs. *Journal of Economic Dynamics and Control* 43:218–40.

Laeven, L. 2001. Insider Lending and Bank Ownership: The Case of Russia. *Journal of Comparative Economics* 29:207–29.

Laeven, L., and G. Majnoni. 2003. Loan Loss Provisioning and Economic Slowdowns: Too Much, Too Late? *Journal of Financial Intermediation* 12:178–97.

Laeven, L., and F. Valencia. 2011. The Real Effects of Financial Sector Interventions During Crises. *IMF Working Paper 11/45* .

Laeven, L., and F. Valencia. 2012a. Systemic Banking Crises Database: An Update. *IMF Working paper 12/163* .

Laeven, L., and F. Valencia. 2012b. The Use of Blanket Guarantees in Banking Crises. *Journal of International Money and Finance* 31:1220–48.

Lane, P. R. 2012. The European Sovereign Debt Crisis. *Journal of Economic Perspectives* 26:49–68.

Li, L. 2013. TARP Funds Distribution and Bank Loan Supply. *Journal of Banking & Finance* 37:4777–92.

Louzis, D. P., A. T. Vouldis, and V. L. Metaxas. 2012. Macroeconomic and Bank-Specific Determinants of Non-Performing Loans in Greece: A Comparative Study of Mortgage, Business and Consumer Loan Portfolios. *Journal of Banking and Finance* 36:1012–27.

Martynova, N., and E. Perotti. 2015. Convertible Bonds and Bank Risk-Taking. *Working paper*.

Messai, A. S., and F. Jouini. 2013. Micro and Macro Determinants of Non-Performing Loans. *International Journal of Economics and Financial Issues* 3:852–60.

Mileris, R. 2012. Macroeconomic Determinants of Loan Portfolio Credit Risk in Banks. *Inzinerine Ekonomika-Engineering Economics* 23:496–504.

Morrison, A. D., and L. White. 2013. Reputational Contagion and Optimal Regulatory Forbearance. *Journal of Financial Economics* 110:642–58.

Mundlak, Y. 1978. On the Pooling of Time Series and Cross Section Data. *Econometrica* 46:69–85.

Myers, S. C. 1977. Determinants of Corporate Borrowing. *Journal of Financial Economics* 5:147–75.

NBER. 2012. Statement of the NBER Business Cycle Dating Committee on the Determination of the Dates of Turning Points in the U.S. Economy.

Niinimaki, J.-P. 2007. Evergreening in Banking. *Journal of Financial Stability* 3:368–93.

Nkusu, M. 2011. Nonperforming Loans and Macrofinancial Vulnerabilities in Advanced Economies. *IMF Working Paper 11/161* .

Ongena, S., A. Popov, and G. F. Udell. 2013. "When the Cat's Away the Mice Will Play": Does Regulation at Home Affect Bank Risk-Taking Abroad? *Journal of Financial Economics* 108:727–50.

Peek, J., and E. S. Rosengren. 2005. Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan. *American Economic Review* 95:1144–66.

Pesaran, M. H., T. Schuermann, B.-J. Treutler, and S. M. Weiner. 2003. Macroeconomic Dynamics and Credit Risk. *CESifo Working Paper No. 995* .

Philippon, T., and P. Schnabl. 2013. Efficient Recapitalization. *Journal of Finance* 68:1–42.

Philippon, T., and V. Skreta. 2012. Optimal Interventions in Markets with Adverse Selection. *American Economic Review* 102:1–28.

La Porta, R., F. Lopez-de-Silanes, and G. Zamarripa. 2003. Related Lending. *Quarterly Journal of Economics* 18:231–68.

Quagliariello, M. 2007. Banks' Riskiness over the Business Cycle: A Panel Analysis on Italian Intermediaries. *Applied Financial Economics* 17:119–38.

Reinhart, C. M., and K. S. Rogoff. 2009. The Aftermath of Financial Crises. *American Economic Review* 99:466–72.

Repullo, R. 2004. Capital Requirements, Market Power, and Risk-Taking in Banking. *Journal of Financial Intermediation* 13:156–82.

Segura, A. 2014. Why Did Sponsor Banks Rescue Their SIVs? *Working paper* :1–47.

Sekine, T., K. Kobayashi, and Y. Saita. 2003. Forbearance Lending: The Case of Japanese Firms. *Monetary and Economic Studies* 2003:69–92.

Spargoli, F. 2012. Banks' Optimal Information Disclosure and Banks' Opacity. *Working paper* .

Steffen, S. 2014. Robustness, Validity and Significance of the ECB's Asset Quality Review and Stress Test Exercise. *Study requested by the European Parliament's Economic and Monetary Affairs Committee* .

Tirole, J. 2012. Overcoming Adverse Selection: How Public Intervention Can Restore Market Functioning. *American Economic Review* 102:29–59.

Watanabe, W. 2010. Does a Large Loss of Bank Capital Cause Evergreening? Evidence from Japan. *Journal of the Japanese and International Economies* 24:116–36.

White, H. 1980. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48:817–38.

Wijnbergen, S. J. G. van. 1997. On the Role of Banks in Enterprise Restructuring: The Polish Example. *Journal of Comparative Economics* 24:44–64.

Wijnbergen, S. Van, and L. Treur. 2011. State Aid and Bank Intervention: The ING Illiquid Assets Back-up Facility (IABF). *Tinbergen Institute Discussion Paper 11-146* .

Williamson, S. D. 1987. Financial Intermediation, Business Failures, and Real Business Cycles. *Journal of Political Economy* 95:1196.

Zoican, M. A., and L. A. Górnicka. 2015. Supranational Bank Resolution and Market Discipline Too-International-to-Fail? *Working paper* .

Samenvatting (Summary in Dutch)

De gevolgen van systematische bankcrises zijn ernstig, zoals blijkt uit de langdurige recessies die er vaak op volgen. Overheden en centrale banken grijpen gedurende bankencrises in om financiële stabiliteit te waarborgen en productieverliezen te limiteren. In dit proefschrift onderzoek ik hoe effectief interventiemaatregelen zijn en wat er gedaan kan worden om problemen in de banksector vroegtijdig te ontdekken. Problemen veroorzaakt door banken met te weinig eigen vermogen vormen het gemeenschappelijke thema van alle hoofdstukken. In de eerste twee hoofdstukken analyseer ik de effecten van interventiemaatregelen gericht op banken in nood vanuit een macro- en microperspectief. Vervolgens kijk ik in meer detail naar forbearance (het oogluikend accepteren van wanbetaling), een van de karakteristieke hoofdproblemen voor ondergekapitaliseerde banken, met als doel te kijken of dit voorspeld kan worden met waarneembare indicatoren op bank- en landniveau. Ten slotte vergelijk ik twee benaderingen voor het evalueren van bankveerkracht: een stress-test en een door markt prijzen geïmpliceerde indicatie van kapitaalgebrek.

In hoofdstuk 2 analyseer ik recessies gerelateerd aan systematische bankencrises. Banken die door 'regulatory forbearance' blijven functioneren ondanks te weinig eigen vermogen, voeren hun bemiddelingsrol niet goed uit. Het is aannemelijk dat zij in zombiebanken veranderen die krediet aan nieuwe kredietnemers rantsoeneren terwijl oude leningen aan insolvente kredietnemers vernieuwd worden om zodoende het erkennen van verliezen uit te stellen. Dergelijk gedrag leidt tot inefficiënte allocatie van productiemiddelen en dat manifesteert zich in langere recessies. Ik vind dat het herkapitaliseren van banken in nood deze problemen substantieel vermindert. Het reduceert de lengte van de recessie met bijna de helft. Andere maatregelen zoals liquiditeitssteun, garanties voor bank passiva, monetair en fiscaal beleid, die het probleem van onderkapitalisatie van banken niet direct adresseren, lijken minder effectief.

In hoofdstuk 3 richt ik mij op de effecten van bank-herkapitalisatie op bankniveau. Ik stel vast dat nadat een bank in nood is geherkapitaliseerd, het verstrekken van leningen toeneemt, deposito's toenemen en dat de bank makkelijker kan lenen op de interbancaire markt. Het schoont tevens de balans op, wat te zien is aan een tijdelijke toename van voorzieningen voor verliezen op leningen. Echter, deze effecten doen zich alleen voor als de herkapitalisatie

groot genoeg is. Banken die een kleine herkapitalisatie, relatief aan hun kapitaalgebrek, ontvangen, reageren anders. Deze banken reduceren leningen en krimpen hun activa om hun kapitaalsratio te verbeteren. Tegelijkertijd ondervinden zij een uitstroom van deposito's en lenen zij minder op de interbancaire market. Deze resultaten suggereren dat de herkapitalisatie groot genoeg moet zijn om de gewenste effecten teweeg te brengen.

In hoofdstuk 4 kijk ik naar 'forbearance', het verlengen of vernieuwen van leningen aan kredietnemers in nood. Uitstel van betaling kan voor sommige kredietnemers economisch verantwoord zijn. Echter, wanneer dit zeer omvangrijk is, wat vaak het geval is tijdens bankencrises, is de bedoeling vermoedelijk het uitstellen van het nemen van verliezen of het gokken op herstel ('gambling for resurrection'). Omdat het aan banken individueel is om een uitstel van betaling voor een lening wel of niet te verlenen, is de mate van forbearance lastig te meten. Ik gebruik de uitkomsten van de asset quality review, uitgevoerd door de ECB in 2014 om indicatoren van forbearance te creëren. De resultaten, die laten zien dat ongunstige macro-economische condities, laks bankentoezicht en indicatoren van bank-weakness de mate van forbearance van banken voorspellen, wijzen op het belang van de kwaliteit van bankentoezicht en voldoende kapitalisatie van banken om te voorkomen dat forbearance wijdverspreid wordt.

In hoofdstuk 5 vergelijk ik twee manieren voor het schatten van de kwetsbaarheid van banken bij ernstige schokken. Stress tests uitgevoerd door centrale banken specifiëren gewoonlijk een ongunstig macro-economisch scenario waaronder de verliezen op verschillende soorten activa geschat worden. De verliezen worden vervolgens geaggregeerd om het totale effect op het eigen vermogen van de bank te berekenen. Methodes gebaseerd op rendementen van aandelen daarentegen, zoals SRISK, leiden informatie over het verwachtte verlies van kapitaal in een ongunstig scenario af van historische rendementen. Een vergelijking van de uitkomsten van de ECB/EBA 2014-stress-test met SRISK laten zien dat terwijl de variatie in verliezen bij banken in de ECB/EBA-stress-test verklaard kan worden door macro-economische condities, balansvariabelen en marktindicatoren, de verliezen geïmpliceerd door SRISK voornamelijk worden gedreven door de initiële leverage ratio. Dit wijst op een mogelijk systematisch onderschatten van risico's bij laag gekapitaliseerde banken en het systematisch overschatten van risico's bij banken met een hoog initieel kapitaal. Het voordeel van methoden gebaseerd op marktdata is dat deze berekend kunnen worden op een continue basis, maar, zoals deze analyse laat zien, kunnen ze zeer belangrijke risico's missen.

Dit proefschrift laat zien dat het ondergekapitaliseerd laten van banken kan resulteren in desastreuze uitkomsten en dat herkapitalisaties effectief zijn mits van voldoende omvang. De noodzaak voor het herkapitaliseren van banken met publieke middelen kan gereduceerd worden

als toezichthouders banken kunnen dwingen hun eigen vermogen te vergroten door marktfinanciering voordat hun verliezen te groot worden. Het identificeren van drijvers van forbearance kan helpen bij het vroeg detecteren van problemen in de bankensector. Verder zijn stress tests een cruciale methode om bankkwetsbaarheden vast te stellen. Het is belangrijk om te kijken hoe stress tests en andere maatstaven van bankrisico presteren, omdat ze kritieke tekortkomingen kunnen hebben. Het nauwkeurig analyseren van interventiemaatregelen en methodes voor het monitoren van risico's kan bijdragen aan het voorkomen van de volgende crisis of tot een beter antwoord leiden als die plaatsvindt.

The Tinbergen Institute is the Institute for Economic Research, which was founded in 1987 by the Faculties of Economics and Econometrics of the Erasmus University Rotterdam, University of Amsterdam and VU University Amsterdam. The Institute is named after the late Professor Jan Tinbergen, Dutch Nobel Prize laureate in economics in 1969. The Tinbergen Institute is located in Amsterdam and Rotterdam. The following books recently appeared in the Tinbergen Institute Research Series:

591 S. RENES, Never the Single Measure

592 D.L. IN 'T VELD, *Complex Systems in Financial Economics: Applications to Interbank and Stock Markets*

593 Y. YANG, *Laboratory Tests of Theories of Strategic Interaction*

594 M.P. WOJTOWICZ, *Pricing Credits Derivatives and Credit Securitization*

595 R.S. SAYAG, *Communication and Learning in Decision Making*

596 S.L. BLAUW, *Well-to-do or doing well? Empirical studies of wellbeing and development*

597 T.A. MAKAREWICZ, *Learning to Forecast: Genetic Algorithms and Experiments*

598 P. ROBALO, *Understanding Political Behavior: Essays in Experimental Political Economy*

599 R. ZOUTENBIER, *Work Motivation and Incentives in the Public Sector*

600 M.B.W. KOBUS, *Economic Studies on Public Facility use*

601 R.J.D. POTTER VAN LOON, *Modeling non-standard financial decision making*

602 G. MESTERS, *Essays on Nonlinear Panel Time Series Models*

603 S. GUBINS, *Information Technologies and Travel*

604 D. KOPÁNYI, *Bounded Rationality and Learning in Market Competition*

605 N. MARTYNOVA, *Incentives and Regulation in Banking*

606 D. KARSTANJE, *Unraveling Dimensions: Commodity Futures Curves and Equity Liquidity*

607 T.C.A.P. GOSENS, *The Value of Recreational Areas in Urban Regions*

608 Ł.M. MARĆ, *The Impact of Aid on Total Government Expenditures*

609 C. LI, *Hitchhiking on the Road of Decision Making under Uncertainty*

610 L. ROSENDAHL HUBER, *Entrepreneurship, Teams and Sustainability: a Series of Field Experiments*

611 X. YANG, *Essays on High Frequency Financial Econometrics*

612 A.H. VAN DER WEIJDE, *The Industrial Organization of Transport Markets: Modeling pricing, Investment and Regulation in Rail and Road Networks*

613 H.E. SILVA MONTALVA, *Airport Pricing Policies: Airline Conduct, Price Discrimination, Dynamic Congestion and Network Effects.*

614 C. DIETZ, *Hierarchies, Communication and Restricted Cooperation in Cooperative Games*

615 M.A. ZOICAN, *Financial System Architecture and Intermediation Quality*

616 G. ZHU, *Three Essays in Empirical Corporate Finance*

617 M. PLEUS, *Implementations of Tests on the Exogeneity of Selected Variables and their Performance in Practice*

618 B. VAN LEEUWEN, *Cooperation, Networks and Emotions: Three Essays in Behavioral Economics*

619 A.G. KOPÁNYI-PEUKER, *Endogeneity Matters: Essays on Cooperation and Coordination*

620 X. WANG, *Time Varying Risk Premium and Limited Participation in Financial Markets*

621 L.A. GORNICKA, *Regulating Financial Markets: Costs and Trade-offs*

622 A. KAMM, *Political Actors playing games: Theory and Experiments*

623 S. VAN DEN HAUWE, *Topics in Applied Macroeconometrics*

624 F.U. BRÄUNING, *Interbank Lending Relationships, Financial Crises and Monetary Policy*

625 J.J. DE VRIES, *Estimation of Alonso's Theory of Movements for Commuting*

626 M. POPŁAWSKA, *Essays on Insurance and Health Economics*

627 X. CAI, *Essays in Labor and Product Market Search*

628 L. ZHAO, *Making Real Options Credible: Incomplete Markets, Dynamics, and Model Ambiguity*

629 K. BEL, *Multivariate Extensions to Discrete Choice Modeling*

630 Y. ZENG, *Topics in Trans-boundary River sharing Problems and Economic Theory*

631 M.G. WEBER, *Behavioral Economics and the Public Sector*

632 E. CZIBOR, *Heterogeneity in Response to Incentives: Evidence from Field Data*

633 A. JUODIS, *Essays in Panel Data Modelling*

634 F. ZHOU, *Essays on Mismeasurement and Misallocation on Transition Economies*

635 P. MULLER, *Labor Market Policies and Job Search*

636 N. KETEL, *Empirical Studies in Labor and Education Economics*

637 T.E. YENILMEZ, *Three Essays in International Trade and Development*

638 L.P. DE BRUIJN, *Essays on Forecasting and Latent Values*

639 S. VRIEND, *Profiling, Auditing and Public Policy: Applications in Labor and Health Economics*

640 M.L. ERGUN, *Fat Tails in Financial Markets*