Securitization and Dividend Payout by Banks

Inaugural-Dissertation
zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Volkswirtschaftlichen Fakultät
der Ludwig-Maximilians-Universität
München

2010

vorgelegt von

Desislava Chavdarova Andreeva

Referent:	Professor Dr. Gerhard Illing
Korreferent:	Professor Dr. Monika Schnitzer
Promotionsabschlussberatung:	17. November 2010

Acknowledgments

The support of many - supervisors, colleagues, friends, and family - helped me to successfully complete this thesis.

First and foremost, I would like to thank my supervisor Prof. Gerhard Illing for his invaluable advice and continuous encouragement whilst writing the thesis. I have learnt a lot from him, not only in lectures and seminars but also in the numerous enlightening discussions about economics and economic policy with him and colleagues at the Seminar of Macroeconomics.

Furthermore, I am grateful to Prof. Monika Schnitzer who kindly agreed to act as my second examiner. I was happy to win Prof. Sven Rady to be my third examiner.

My co-authors Ivan Andreev and Katri Mikkonen I thank for the inspiring and productive cooperation. Special thanks go also to my dear current and former colleagues at the Seminar for Macroeconomics Julia Bersch, Agnes Bierprigl, Josef Forster, Moritz Hahn, Florian Kajuth, Stephan Sauer, Sebastian Watzka, Sebastian Jauch, Sebastian Missio and Michael Zabel, as well as to all former student assistants.

I am grateful to my parents and brother for distracting me from research and teaching every time I was back in Bulgaria and to Ivan for having been by my side the last 10 years.

Desislava Chavdarova Andreeva

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Chapter 1

Introduction

The still ongoing financial crisis is the common thread connecting the chapters of this thesis on securitization and dividend payout by banks. Triggered by defaults on subprime mortgages in the United States, the crisis was first labeled “The Subprime Crisis”. The risky mortgages had been securitized and sold to investors all over the world, among others to banks. Losses on mortgage-backed securities wiped out the banks’ capital cushions[1] and triggered “The (Systemic) Banking Crisis”. As a consequence, the developed nations’ GDP dropped by 3.2% in 2009 and world trade by 12.3%;[2] “The Great Recession” emerged. Governments and central banks intervened and were at first successful in stabilizing the financial system and reviving aggregate demand. However, currently concerns about the sustainability of mounting government debt levels have arisen and have led to the outbreak of the sovereign “Debt Crisis” in the euro area.[3]

[1]See International Monetary Fund (2010)a, the April 2010 Global Financial Stability Report, Figure 1.11 and Table 1.2 for an estimate of global bank writedowns by region.

[2]See International Monetary Fund (2010)b, the World Economic Outlook Update from 26/01/2010, Table 1.1.

[3]The IMF distinguishes four phases of the crisis: a systemic buildup from July 2007 to September 2008 which corresponds to the “Subprime Crisis”, a systemic outbreak form October 2008 to March 2009 - the “Banking Crisis”, a systemic response until October 2009 capturing the government intervention to calm markets and dampen the adverse effects on the real economy during the “Great Recession”, and a still on-going sovereign risk phase. See Global Financial Stability Report April 2010, Box 1, page 7. For a detailed timeline of events from the US perspective, see the Financial Crisis Timeline available on-line on the web page of the Federal Reserve Bank of St. Louis.

Introduction

The focus of this thesis is on aspects of the behavior of banks both in the run-up phase and during the financial crisis outbreak. The individual chapters are arranged in a chronological order, reflecting the evolution of issues concerning the banking system and resulting research ideas thereof.[4] I started working on it in the early summer of 2007, at the stage of the "Subprime Crisis". Thus, the focus of the next two chapters is on understanding the trigger event: losses on asset-backed securities. The questions addressed are why do banks engage in securitization, how does securitization affect banks' incentives to monitor borrowers, and how does it influence the amount of bank credit?

Not long ago, securitization was considered by and large a beneficial financial technique, that allows a better diversification of risk, and therefore increases welfare. Currently asset-backed securities are being called by some "toxic waste assets". In a recent on-line debate on the topic of financial innovation and growth, organized by the Economist magazine, Joseph Stiglitz claimed that "..[these] financial products increased the problems of information asymmetry, exacerbating problems of moral hazard. Indeed much of the growth of some of these products can be attributed to these information problems, and perhaps to the deliberate exploitation of the uninformed."[5]

Focusing on the information asymmetry inherent in securitization, the second chapter of this thesis presents a simple model of securitizing banks and investors in asset-backed securities. For the analysis I augment the principal-agent framework used by Innes (1990) and use the optimal contract proposed by him and Pennacchi (1988). I investigate how securitization affects the quantity and quality of bank credit as well as its welfare effects considering first a single friction: asymmetric information between originator-underwriters and investors. Securitization is assumed to help banks to reduce their funding costs by allowing them to circumvent capital regulation. How-

[4]The evolution of the crisis, as unique it may be in the detail, followed a general pattern similar to historical financial crises, see Reinhard and Rogoff (2008). For a description of historical patterns and crises, see further Kindleberger and Aliber (2005), among others.

[5]See Stiglitz (2010) in the Economist debates, "This house believes that financial innovation boosts economic growth", February 23 2010. See also Ashcraft and Schuermann (2008).

ever, it also impairs banks' incentives for diligent monitoring.

In its baseline version the model yields three predictions: first, securitized loans are less well monitored than retained loans originated by the same bank, and, second, under certain parameter values it is possible that a higher than the first best fraction of loans is securitized. Therefore, the average quality of loans is too low both because securitized loans are inefficiently monitored and there may be too many of them. Third, total bank credit increases.

Overall welfare in the baseline framework is improved as the cost reduction due to securitization outweighs the adverse effects of inefficient monitoring. However, securitization may lead to substantial welfare losses and mis-allocate funds away from more profitable investment projects to poorly underwritten and thus badly performing securitized assets, if additional frictions impair the willingness or ability of investors to adequately price asset-backed securities. Ashcraft and Schuermann (2008) provide an overview of the numerous interlinked frictions present in the securitization process and conclude that a combination of five of them, has lead to the sub-prime crisis.

In the subsequent chapter, Ivan Andreev and I use a panel dataset of 506 large commercial banks in the United States to empirically investigate how securitization affects the quality of originated loans and whether banks engage in it to circumvent capital adequacy regulation. We are able to empirically confirm the driving assumption and one of the predictions of the theoretical model from the second chapter of this thesis.

Contrary to most previous studies we find evidence of a regulatory arbitrage motive. The data further suggest that securitization impairs the incentives for screening and monitoring by originating institutions. The commonly used techniques for overcoming such incentive problems - seller-provided credit enhancements - do not seem to help remedy moral hazard and adverse selection problems. Instead sufficient levels of capital at credit institutions lead to the origination and securitization of better quality assets. Our research indicates that capital adequacy regulation is a double-edged sword: whereas loopholes in the regulatory framework can seduce banks to securitize assets just for the sake of not having to hold regulatory capital, sufficient levels of capital do give banks the right incentives for prudent behavior.

In the course of the crisis governments and central banks intervened to prevent a meltdown of the financial system. Given the large amount of tax payers' money at stake, both directly because it was injected in ailing banks and indirectly because of government-guaranteed bank liabilities, concerns arose that the capital buffers of banks may be further diminishing due to excessive management remuneration or high dividends. Contrary to compensation packages, dividends are not a contractual obligation of the banks and, therefore, can be canceled by the management. Thus, the last chapter of the thesis focuses on the questions: Did capital leak out of the banking system in the form of dividends at the time of turmoil? Why did it leak and did banks on the brink of bankruptcy continue to remunerate shareholders?

The chapter is based on a joint work with Katri Mikkonen. Using the updated dataset of 506 large commercial banks for the United States from chapter 3 and data on banks operating in the 27 member states of the European Union, we investigate whether the surge in dividend-to-profit ratios in 2007 and 2008 could be attributed to banks with low capital buffers or subject to high credit risk, implying imprudent behavior and avoidance of capital accumulation in times of crisis, as suggested by Acharya et al (2009). For US banks participating in the government support program, we observe a significant shift of dividend policies towards higher sensitivity to credit risk and lesser smoothing of the dividend level over time. US banks that have not received support have, in contrast, not significantly adjusted their dividend policies: for these banks, dividends seem to have declined only gradually following the sharp profitability shock, which, in the short run, has further weakened the banks' capital buffers. Similarly to the results on the US banks receiving state support, European banks seem to have increased the influence of credit risk considerations on dividend decisions. However, we also find some evidence for stronger dividend smoothing during the crisis period compared to the period up to 2008. In sum, most of the observed surge in payout-profit ratios can be explained by the attempt of banks to smooth the absolute levels of dividends, as net profits have declined. We do not find any evidence of excessive dividend payments by credit institutions with very low capital buffers or subject to high credit risk.

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Chapter 2

Securitization, incentives, and bank lending: A principal-agent model

2.1 Introduction

The core business of banks is the funding of illiquid long-term loans by collecting demand deposits. The structure is crucial to give bank managers the right incentives. The maturity mismatch of the asset and liability side of their balance sheets makes banks prone to runs and gives rise to an inherent fragility. However, it also induces relationship lenders to pay the entire amount they expect to collect from borrowers to depositors.[1] The illiquidity of originated loans implies simply that banks hold them until maturity. Ultimately, all the risk and benefits associated with a loan are bundled and stay with the bank. This ensures a careful screening of loan applicants and diligent monitoring once a loan has been granted.

As the current crisis evolved, it became apparent that illiquid financial claims, i.e. mortgages, had been transformed into tradable debt securities on a large scale. These, in turn, were sold to investors all over the world. The large scale mortgage securitization was accompanied by origination of riskier "sub-prime" mortgages and lax underwriting standards. High delinquencies rates on those mortgages made the securities structured out of them worthless and triggered a global financial crises with devastating repercussions to the real economy.

To understand the trigger of the crisis we have to explore how the transformation of illiquid loans into marketable securities affects bank lending. This paper focuses on the effect of securitization on incentives for diligent monitoring of borrowers and on the amount of bank lending provided. I use a simple principal-agent model featuring risk-neutral banks and risk-neutral investors in asset-backed securities, both subject to limited liability rules. The driving assumption in the framework is that banks have a superior knowledge about the loans they have originated. The optimal securitization contract between investors and banks is a debt-like covenant, as shown in a general setting by Innes (1990). A similar optimality result for the securitization contract is

[1] See Diamond and Rajan (2000) and Diamond and Rajan (2001), the fragile capital structure remedies a hold-up problem between bankers with a rare expertise in extracting repayments from borrowers and the bankers' creditors.

shown by Pennacchi (1988). The contract has the basic features of real-life true securitization, in which originating banks retain a subordinated stake, i.e equity piece or first-loss piece, and sell a senior claim on the interest and principal payments of the securitized loans.

Securitization allows banks to reduce their costs but gives rise to a moral hazard problem. Ultimately banks lend more, as there are more profitable lending opportunities given the lower funding costs. The additionally supplied loans are, however, inefficiently monitored. Furthermore, banks may be seduced into securitizing a higher fraction of loans than they would do in the first best case. Loan quality is on average lower than optimal because securitized assets are poorly monitored and too many of them may be securized.

The aggregate lending in the economy increases at the cost of inefficient monitoring. Nevertheless, in this simple framework overall welfare is improved as the cost reduction advantage of securitization outweighs the adverse effects of inefficient monitoring. Securitization, though, can lead to substantial welfare losses by mis-allocating funds away from more profitable investment projects to poorly underwritten and thus badly performing loans if investors in asset-backed securities do not carefully assess the risks associated with the securities they buy.

The literature on securitization can be traced back to Greenbaum and Thakor's (1987) "Banks funding modes". In the equilibrium of their adverse selection model banks hold riskier assets and securitize the "good" ones. Pennacchi (1988) focuses on why banks engage in securitization and which securitization contract allows banks to maximize the loan sales volume under asymmetric information. Gorton and Pennacchi (1995) stress the distortionary effect of loan sales on monitoring incentives. In a recent paper Cerasi and Rochet (2008) come to the opposite conclusion. They show that loan sales and credit derivatives can provide optimal insurance to banks without impairing incentives. Arping (2004) and Chiesa (2008) show that securitization may even lead to better incentives for monitoring.

My approach is closely related to Pennacchi (1988) and Gorton and Pennacchi (1995). I use the basic structure of a principal-agent model and the optimal securitization contract proposed by Pennacchi (1988). However, a more general proof of the optimality of the debt-like contract is available in Innes (1990). Therefore, I stick to Innes' (1990) line of argument in this paper. Using the optimal contract, I focus on how securitization affects the aggregate amount on bank lending and the average quality of bank credit. I use a richer setting, in which banks choose the scale of lending and are allowed to fully retain some of the loans. Depending on whether loans are subsequently securitized or retained, banks are allowed to monitor loans with a different intensity. The more complex setting allows me to directly address the question how securitization affects the amount of lending and whether securitized loans are less carefully monitored compared to retained loans.

In the next section I briefly describe what securitization is and give a short summary of the related literature. Subsequently, I present the regulatory requirements and accounting practices affecting my modelling strategy in section 2.4. I set up the baseline model in section 2.5 and describe the securitization contract in section 2.6. To simplify the analysis I first describe the credit market outcome in case securitization is not feasible and in case no asymmetric information with respect to the monitoring intensity exists, in sections 2.7 and 2.8.1. The outcomes are used as benchmarks for the main result in sections 2.8.2 and 2.9. Subsequently I discuss the driving assumptions and the limitations of the model in section 2.10 and conclude.

2.2 The basic securitization process

Securitization is the transformation of illiquid financial assets into tradable securities.[2] In a typical transaction[3] the assets are pooled and transfered to a separate entity settled only for the purpose of holding such assets - a special purpose vehicle. In the next step the special purpose vehicle issues debt-like securities and uses the proceeds to pay the originator of the assets. The securities represent claims on the future cash flow from the underlying

[2]See Greenbaum and Thakor (1987), p. 379.

[3]See Schwarzs (1994), among others.

asset pool.[4]

Ultimately, the assets are removed from the balance sheet of the "seller" onto the asset side of the balance sheet of the special purpose entity. The asset-backed securities are its liabilities. In the simplest possible transaction only one class of securities is issued and the cash flow is distributed proportionally to investors. More often though, special purpose vehicles issue multiple classes of securities that differ in their seniority and maturity - "tranches". In that case, the cash flows are first distributed to the holders of the most senior tranche. Subsequently, investors in more junior tranches are paid. The holder of the most junior tranche, called the "equity piece" or the "first loss piece", is not paid until all the other investors have received the due payments.

The order in which investors are affected by occurring defaults is the opposite. The equity piece is affected from the very first. It covers all the losses up to its par value so that the more senior tranches are impaired only if defaults exceed this threshold; effectively, it is a credit enhancement. Originators typically retain the equity piece.

2.3 Literature review

The theoretical literature on credit risk transfer and securitization can be traced back to Greenbaum and Thakor's "Bank Funding Modes", published in 1987 in the *Journal of Banking and Finance*. They analyze why banks choose to fund assets via securitization versus the traditional issuance of deposits in an adverse selection framework. Greenbaum and Thakor (1987) emphasize the role of bank regulation and the advancing information processing technology. In the equilibrium of their model banks hold riskier assets and securitize the "good" ones. Subsequent literature can be roughly divided into two main strands: The first explores the scope for risk sharing between the banking sector and other sectors in the economy as well as its effects on the stability of banks and possible contagion. The second puts

[4] Often the originating institution acts as a servicing agent: it collects the interest and principal payments and passes them to the investors for a fee.

more emphasis on the implications for the monitoring of loan applicants and the quality of originated loans. Those two strands are intrinsically linked. Risk sharing via securitization insulates banks from losses and, in a world with asymmetric information and limited liability, alters incentives to prevent defaults. Thus, any beneficial effect from risk transfer from the arguably more vulnerable banking sector to more stable sectors in the economy will be attenuated by the adverse effect on the monitoring incentives. Additionally, incentive problems in securitization can lead to origination of bad loans and thus can undermine the safety and soundness of banks if part of the risks associated with those loans are retained by the originator.

Let me very briefly summarize the most recent theoretical contributions, starting with the theoretical papers on risk sharing and its effects on the financial system stability. In Allen and Gale (2007) banks securitize assets to circumvent capital regulation. They show that inefficiently high capital adequacy requirements for banks induce credit risk transfer to an insurance sector. The link between the two sectors gives rise to systemic risk: problems in the insurance sector can spread to the banking industry. Based on an augmented version of this model, Allen and Carletti (2006) focus on the interaction between idiosyncratic liquidity shocks and credit risk transfer to create contagion. In their model securitization is truly driven by risk sharing considerations. Risk sharing is desirable because the sectors engage in activities with imperfectly correlated returns. Credit risk transfer induces insurers to hold a long term security, which otherwise is held by banks only. Contagion arises because bad outcomes for insurance companies force them to sell the long security. This in turn harms banks hit by adverse liquidity shocks as they use the long security to refinance in the interbank market. Depressed prices of the long security do not allow them to collect the necessary resources to pay out depositors and leads to bankruptcies.[5] In those models banks do not perform screening and monitoring of borrowers, the emphasis lies on the implications for the stability of individual banks and arising contagion effects.

[5]See also Wagner and Marsh (2006).

One of the early papers focusing on incentives is the work of Gorton and Pennacchi (1995). The authors stress the adverse effect of securitization on the quality of originated loans. Banks selling a proportional claim on loans do not bear the full loss if those loans default and thus their incentives for borrower monitoring are distorted. In a recent paper, Fecht and Wagner (2007) show that securitization alleviates the hold-up problem between bank managers and shareholders, which ceteris paribus allows a safer capital structure with a higher equity share. Securitization can therefore potentially improve the stability of banks. However, because rents collected by managers are lower, their incentives to monitor borrowers are damaged. On the contrary, Chiesa (2008) shows that securitization can lead to better incentives for monitoring. The result arises in a framework of banks prone to gamble on good economic outlook instead of stringently screening whom to grant a loan. Securitization alleviates the incentives for gambling and induces banks to exert monitoring effort. Arping (2004) demonstrates that securitization can have a beneficial effect on the incentives of borrowers without to impair the monitoring by lenders. In his framework securitization facilitates the ex-post enforcement of the debt contract between borrower and lender. Cerasi and Rochet (2008) show that loan sales and credit derivatives can provide optimal insurance to banks without impairing incentives.

The most closely related papers to my research agenda are Pennacchi (1988), focusing on why banks securitize assets and on the design of the optimal securitization contract, and Gorton and Pennacchi (1995), on the effects of loan sales on monitoring incentives. In a first step Pennacchi (1988) derives the after-tax profit maximization problem of a bank subject to capital adequacy constraints. A tax-disadvantage makes equity funding more costly than funding via deposits. In the optimum the capital constraint is binding and banks are forced to use more equity than they would freely choose. Banks are then allowed to finance a fraction of all of their one-dollar loans via loan sales. For simplicity, the fraction is assumed to be equal for all individual loans held by the bank. By selling loans a bank can partially circumvent the necessity to fund them via equity and therefore can lower its funding costs. The optimal contract is determined for the sale of an individual one-dollar loan. If no loan sales with recourse are allowed, the optimal contract features a payment to the originating bank only if no default of the borrower occurs. In the case of default, all proceeds from collateral, restructuring etc., accrue to the buyer of the loan. The contract cannot support first best levels of monitoring.

In Gorton and Pennacchi (1995) the focus is on the incentive effect of the sale of one-dollar loan by banks. Banks selling a proportional claim on loans do not bear the full loss if those loans default and thus their incentives for borrower monitoring are distorted. The sale contract is, however, not the optimal, but an exogenously given linear one. Pennacchi (1988) further argues that a specialization in banking may emerge: banks with a competitive advantage in deposit collection would buy securitized assets, whereas large money-center banks would focus on the origination and subsequent sale of assets.

Similarly to Pennacchi (1988) and Gorton and Pennacchi (1995), in my framework an informational asymmetry undermines the efficient monitoring by banks. Banks use the optimal covenant given limited liability restrictions. I do not prove the optimality but rather use the poof by Innes (1990). I focus on how securitization affects the aggregate amount on bank lending and the average quality of bank credit. I use a richer setting, in which banks choose their overall scale of lending and are allowed to retain some loans fully. Depending on whether the loans are subsequently securitized or not, banks are allowed to monitor at different intensities. The more complex setting allows me to directly address the question how securitization affects the amount of lending and whether the securitized loans are less carefully monitored compared with the retained loans.

2.4 Related regulation and accounting rules

Several features of the current banking regulation and accounting rules affect bank behavior and constrain the feasible securitization contracts. Before incorporating the restrictions in the theoretical model, I briefly review the relevant rules, focusing on the Basel Capital Accords and accounting standard related to securitization.

According to the Basel Capital Accord 1988, banks are required to hold a minimum amount of capital of 8% of their risk weighted assets and off-balance-sheet exposures. It is generally accepted that minimum capital adequacy requirements increase the funding costs of banks as they are forced to hold a higher amount of "expensive" equity than they would have chosen otherwise.[6] To smooth the effects of possible adverse profitability shocks and avoid becoming capital constrained, banks hold capital well above the minimum required amount.[7] Securitization of assets can help fund loans at lower costs, as it leads to regulatory capital relief. The credit risk associated with securitized loans is transferred to the market, and, the bank is thus no longer required to hold capital against these risks. Capital is set free to back the credit risk inherent to newly originated loans.

To get regulatory capital relief, transactions must be structured so that a significant part of the risk is transferred to investors.[8] Assets must be transferred to an independent special purpose vehicle and the bank does not maintain effective or indirect control over them. In that case the special purpose vehicle is considered "bankruptcy remote" in the sense that the assets that used to be owned by the bank are legally isolated from it and

[6]Forcing banks to hold a higher capital cushion is the aim of the regulation. The more equity a bank holds, the bigger the loss to bank owners in the case of bankruptcy, which should foster incentives for efficient monitoring and curb incentives for excessive risk-taking.

[7]Capital constrained depository institutions can either be forced to let possible new profitable lending opportunities forgo, which lowers their market value, or try to raise new capital by issuing new stocks, which is very expensive. This effect has been widely discussed in the literature on the capital crunch and the bank capital channel of monetary policy. For empirical evidence of the effects of capital constraints on bank lending, see for example Bernanke and Lown (1991) for the USA, whereas a theoretical model can be found in Van den Heuvel (2007). Thus banks hold capital buffers to self-insure against this risk.

[8]Currently the securitization framework of the New Basel Capital Accord (2006) is applicable in the EU, whereas in the USA it is not implemented yet. The applicable capital adequacy guidelines for risk exposure to asset securitization in the USA became effective on January 1 2002. See Federal Register, Vol. 66, No. 230/Thursday, November 29, 2001/ Rules and Regulations. Despite some minor differences, the necessary requirements for obtaining regulatory capital relief in the USA and EU are common.

are no longer part of its bankruptcy estate. They are beyond the reach of its creditors in case of bankruptcy or receivership. This is stated in §554 of the New Basel Capital Accord and is a prerequisite in the USA for special purpose vehicles to gain acceptance as issuers of securities in the capital markets.[9] The issued asset-backed securities are not a liability of the bank. They represent claims against the special purpose vehicle. Thus on the one hand the bank generally has no obligation to reimburse investors in case its assets do not perform as well as expected, and on the other hand investors do not need to fear the financial distress of the bank. They can evaluate how risky the asset-backed securities are by assessing the risks associated with the underlying asset pool and considering the exact structure of the transaction. They do not need to acquire additional information regarding the chance of a bankruptcy of the originating bank.

A further important feature of securitization is that investors and originating banks are not equally well-informed about the quality of the underlying assets. Potential borrowers apply for credit at the bank, and they are approved or denied credit after their creditworthiness has been evaluated according to its proprietary credit scoring program. In that sense, banks have a superior knowledge both about individual loans in a pool and about the scoring technique. Investors are concerned that the bank may exploit its informational advantage and sell assets with lower quality whilst "cherry-picking" the good ones to keep them in its possession.[10]

The easiest way banks could assure potential investors of the good quality of the assets is by selling them with recourse or by fully guaranteeing the timely payments of interest and principal. The risks associated with the securitized assets remain with the bank, and thus it has the same incentives to evaluate and monitor credit applicants in the origination process as if the

[9] See Schwarz (1994), page 135.

[10] See US Securities Exchange Commission (2003), section IV: "Some market participants have expressed concerns that participants in the MBS markets use information they obtain in their capacities as originators, guarantors and servicers, among others, to select for purchase, sale or retention MBS or underlying mortgage loans that have more favorable characteristics than the average universe of MBS or mortgage loans. Assertions have been made that these entities have an unfair advantage over the marketplace generally in purchasing and selling MBS."

loans are to be held on its balance sheet. However, this does not lead to any regulatory capital relief. [11] By retaining a portion of the risk - typically the first loss piece - banks attempt to signal to investors that the securitized assets are worth holding and attain some capital relief.[12]

Besides such explicit contractual risk retention, banks may provide implicit credit enhancements and assume substantially higher risks than one would infer by just looking at the balance sheet. Since outsiders cannot easily observe and verify whether an implicit agreement has taken place, it is not possible to account for such implicit recourse in the calculation of the risk based capital. This undermines the safety and soundness of the banking system and authorities penalize banks for providing any non-contractual support.[13]

2.5 A principal-agent model of securitization

I incorporate those features in a simple model of a competitive banking industry and investors in asset-backed securities and analyze the impact of securitization on bank lending. There are two dates: $t = 0$ and $t = 1$. There are n banks and numerous investors. Both types of agents are risk neutral and have limited liability. n is high enough to assure competitive credit markets.[14]

[11]See the New Basel Capital Accord (2006) §83(i) and 83(ii), such full guarantees constitute direct credit substitutes. For them a credit conversion factor of 100% is applicable.

[12]Banks are required to hold regulatory capital against all of the exposures they have retained, for regulatory purposes the first loss piece is to be deducted from capital.

[13]Implicit recourse is identified ex post if for instance banks support securitization beyond their contractual obligation. By doing so on one occasion banks can signal to markets that the risk associated with their securitized assets stays with them. If implicit support has taken place the bank is required to hold capital against all underlying exposures of a structure, as if they were not securitized. The bank has to disclose publicly that it has done so and the resulting increase in capital charge. If it happens more than once the bank can be required to hold capital against all assets it has securitized, and not be allowed to gain capital relief on securitized assets for a period of time or even be required to hold capital in excess of the minimum risk-based capital ratios, see the New Basel Capital Accord (2006) §792 and the Interagency Guidance on Implicit Recourse in Asset Securitization (2002), `http://www.federalreserve.gov/boarddocs/SRLETTERS/2002/SR0215a1.pdf`

[14]I assume the number of banks competing in the market to be exogenously given and fixed. This is, admittedly, a weakness of the model. However, the number can be

Banks in the economy are ex ante identical. Each one of them is managed by a risk-neutral entrepreneur, who maximizes the expected profit of his bank. A representative bank i receives a stochastic pay-off of $\pi_i \in [0, L]$ per unit of funding I_i given to borrowers. The assumption is justified if the identical banks in the competitive economy offer potential borrowers similar contracts, featuring a contractual payment of L per unit of funding received. In case no borrower defaults, bank i gets LI_i back. As some get into financial distress, the actual realization of π will regularly be lower than L.

The banker can not perfectly control defaults. However, he influences their probability by exerting managerial effort e. The stochastic pay-off π is distributed according to the conditional distribution function $H(\pi|e, Y)$, the respective probability density function is $h(\pi|e, Y)$. Here Y denotes the aggregate amount of credit in the economy.

It is assumed that higher entrepreneurial effort e makes higher outcomes of π more likely, so that $E(\pi|e_1, Y) > E(\pi|e_2, Y)$ if $e_1 > e_2$. One can interpret e in this banking application as the effort a banker must exert to properly asses the creditworthiness of potential borrowers and monitor their projects as he grants a loan. It is further assumed that the probability density function $h(\pi|e, Y)$ has the monotone likelihood ratio property with respect to e. In that case a higher realization of π is a strong signal that the banker has diligently assessed risks and monitored borrowers. Additionally $H(\pi|e, Y)$ is convex in e for any given level of π.[15] The level of e_i is private knowledge of the banker i and is not observable by outsiders, in particular by investors. This captures the informational asymmetry between originating banks and investors in asset-backed securities with regard to the quality of the loans.

The expected return further depends on the aggregate amount of lending Y in the economy. The higher Y is, the lower is the expected return other

made endogenous in a general setting if fixed costs of banking exist. Given these fixed costs, exactly n banks can operate in the marketplace and make zero economic profits. Securitization will generally influence the number of banks that the market can support. The interaction between the competitiveness of the credit market and securitization is not addressed in the current paper.

[15]This assures that the maximization problem is concave in e and allows the usage of the first order approach in a principal-agent model, see Holmström (1979), Rogerson (1985), Jewitt (1988).

things being equal: $E(\pi|e, Y_1) > E(\pi|e, Y_2)$ if $Y_1 < Y_2$. It is motivated by diminishing marginal returns to capital at the aggregate level of the economy. I interpret $E(\pi|e, Y)$ as broadly capturing the aggregate demand for capital in the economy.[16]

Bankers dislike exerting effort. Having to monitor a loan portfolio of size I_i with an intensity of e_i leads to a disutility measured in monetary units of $c(e_i, I_i) = ce_iI_i$. The chosen cost function implies constant marginal monitoring costs per euro of funding granted to borrowers.[17]

The usual way banks fund loans is by issuing demand deposits and retaining earnings or issuing new equity. I label this "on-balance-sheet" funding. The on-balance-sheet funding costs are $f(I_i)$. The cost function is strictly increasing and strictly convex. We can interpret this in the light of capital adequacy regulation in the following way: if at a given point of time a bank is well capitalized, it can easily issue demand deposits or other forms of debt. As the loan portfolio of the bank grows, so does its leverage. It becomes more expensive to raise additional non-insured debt. At some point the bank becomes capital constrained and needs to issue new equity to fulfill its minimum regulatory capital requirements. As I_i grows arbitrarily large the on-balance-sheet costs approach infinity. Let us additionally assume that $f'(0) = 0$ and $f(0) = 0$.

Alternatively, the bank can originate loans and securitize them. I label this "off-balance-sheet" funding. This does not imply disintermediation. Potential borrowers still first approach the bank, apply for a loan, and are denied, or approved and monitored by the banker. In this framework banks are the only institutions endowed with the special ability to influence the outcome of π by exerting entrepreneurial effort. Banks can, though, figuratively outsource the funding of the loans to investors.

Investors in the economy are identical, risk neutral, and competitive. They require an expected return of at least ρ to hold asset-backed securities. It is further assumed that investors, like bankers in the economy, know the distribution function $H(\pi|e, Y)$ and the maximization problem of

[16] Even though I do not model borrowers explicitly.

[17] The assumption is made for simplicity.

bankers. Because for values of I higher than a certain threshold the marginal on-balance-sheet costs $f'(I)$ become higher than ρ, bankers can reduce the overall funding costs by financing a part of the loans via securitization.

The time structure of the model is simple: at time $t = 0$ banks in the economy originate loans. They decide at the time of the origination which of them they would like to keep on their balance sheets, how many are to be securitized and the banker exerts effort e. It is possible that the loans to be held and those to be securitized are monitored with a different intensity. Banks offer investors a securitization contract that maximizes the bank's expected profits. Investors accept or deny. At time $t = 1$ the payoff are realized and split according to the securitization contract.

2.6 The securitization contract

The unobservability of monitoring effort gives rise to a moral hazard problem. Once the bank has sold loans to investors, it is no longer adversely affected by defaults. Thus, it has no incentives to exert effort and improve the future performance of loans if it plans to sell them without retaining any exposure. This is correctly anticipated by investors and lowers their willingness to pay for asset-backed securities. The only way the bank can credibly commit itself to exert monitoring effort is by retaining a stake. Thus in a real world setting, banks would originate loans, transfer them to a special purpose entity and hold some of the asset-backed securities issued. The rest of the securities are sold to investors.

A securitization contract in this set-up specifies the distribution of the cash flows from the underlying assets among the stakeholders conditional on the $t = 1$ realization of the pay-off.

Let us consider a bank i which plans to securitize a pool of loans with a par value of 1. Let π_i^s denote the stochastic pay-off from these assets in $t = 1$. To signal the quality of the underlying assets, the bank retains a stake in the pool. Let $B(\pi_i^s)$ denote the payment to investors conditional of the outcome of π_i^s. The bank receives the residual $\pi_i^s - B(\pi_i^s)$.

The set of admissible contracts is restricted by the limited liability rules in force in the economy. Limited liability of investors impose the restriction:

$$B(\pi_i^s) \geq 0 \tag{2.1}$$

Furthermore, the liability of the originating bank is limited by its retained stake, thus:

$$\pi_i^s - B(\pi_i^s) \geq 0 \tag{2.2}$$

Equation 2.2 simply states that issued asset-backed securities are not liabilities of the originating bank. Therefore, investors can at most get the entire pay-off stream of the securitized loans and do not have a recourse to the originating bank in case the pay-off is not as high as expected.

Furthermore, $B(\pi_i^s)$ is constrained to be non-decreasing in π_i^s. This restriction can be imposed as proposed by Innes (1990), p.50, because otherwise investors would have an incentive to sabotage the bank in any decreasing segment of $B(\pi_i^s)$. Alternatively, if the bank observes a perfect signal of π_i^s slightly before investors, it would have an incentive to secretly supplement the pay-off in any decreasing region of $B(\pi_i^s)$. Thereby it could reap a higher payment of $\pi_i^s - B(\pi_i^s)$ at the expense of investors. In this application the later justification is particularly relevant. Originators often act as servicing agents in exchange for a small fee. They collect the incoming interest and principal payments and keep records of the outstanding balances. The cash flow is distributed with a slight delay to investors in the asset-backed securities, so banks may indeed observe the pay-off slightly earlier.

Given the limited liability and monotonicity restrictions, the optimal contract is of the form $B(\pi_i^s) = \min\{\pi_i^s, R\}$, where R is a constant, see Innes (1990), Lemma 2. The optimality result is fairly intuitive: this kind of contract gives banks the lowest possible payment in bad states of the world given its liability limits, namely nothing. In good states, the bank is residual claimant on the margin. The contract induces the bank to prevent bad outcomes and to make good states more likely by exerting effort. First best effort levels, though, can only be supported by harsher punishments in bad states.

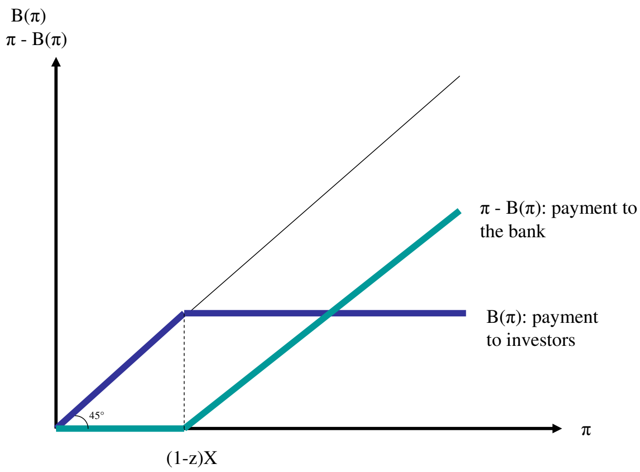

Figure 2.1: Cash flows

Limited liability on the side of banks makes such outcome not feasible, see Innes (1990), page 54, discussion of Lemma 2.

This contract has the distinctive properties of real securitization. The incoming $t = 1$ cash flow from the underlying assets is split and repackaged to form two securities: a first loss piece retained by the originating bank and a senior tranche held by investors in asset-backed securities. Just to illustrate this, let the size of the equity piece be z and investors hold debt-like asset-backed securities with a par value of $1-z$ and interest rate of X. If the pay-off π_i^s in t=1 is greater than $(1-z)X$ investors are fully paid and the bank gets the residual. Otherwise, the bank gets nothing and the full π_i^s is paid to investors. Effectively, at time t=0 the banks sells a derivative contract on the pool of loans of the form $B(\pi_i^s) = \min\{\pi_i^s, R\}$, where $R = (1-z)X$.

Figure 2.1 shows the cash flows to investors and bank contingent on the realization of π_i^s.

In my further analysis I concentrate on the moral hazard issues arising between originating bank and investors in asset-backed securities if they sign contracts of the previously described form. I am particularly interested in the effects of securitization on the amount of bank credit available in the economy and the monitoring intensity of securitized loans. I do not explore whether the securitization contract is renegotiation-proof and do not consider possible adverse or beneficial effects of anticipated subsequent renegotiation on the initial incentives of banks and investors.[18]

Before I start exploring securitization and its implications for the bank lending in the economy, I briefly characterize a benchmark economy, in which only on-balance-sheet funding is possible.

2.7 Benchmark: no securitization

Each bank chooses the intensity of monitoring e_i of its loan portfolio and the amount of lending I_i as to maximize expected profits, taking the aggregate amount of lending Y as given.[19]

$$\max_{e_i, I_i} \; I_i \int_0^L \pi dH(\pi|e_i, Y) - f(I_i) - ce_i I_i \tag{2.3}$$

The first order conditions with respect to e_i and I_i are:

$$\int_0^L \pi dH_{e_i}(\pi|e_i, Y) = c \tag{2.4}$$

$$\int_0^L \pi dH(\pi|e_i, Y) - ce_i = f'(I_i) \tag{2.5}$$

The first order condition with respect to e_i states that in the optimum the increase in the expected pay-off per unit of funding given to borrowers due to higher monitoring is exactly offset by the surge in monitoring costs on the margin. Equation 2.5 determines the amount of lending provided by bank i: the marginal on-balance-sheet funding costs equal the marginal gross income minus induced additional monitoring effort costs at the optimum.

[18] First, the only renegotiation on which both parties can agree in real world would take place in bad states of the world, when $\pi_i^s \leq R$, and be favorable to investors. Banks, concerned that they may lose their reputation, and therefore be unable to securitize loans in the future, may be willing to renegotiate and cover part of the losses incurred by investors. Any such "investor friendly" renegotiation is deemed "implicit recourse". Banks are penalized by supervisory authorities for providing such support.

[19] I use the following notation: $\int_0^L \pi dH(\pi|e_i, Y)$ is equivalent to $\int_0^L \pi h(\pi|e_i, Y) d\pi$. Furthermore, for any function $f(x, y, z)$, $f_x(x, y, z)$ captures the first derivative with respect to the variable x.

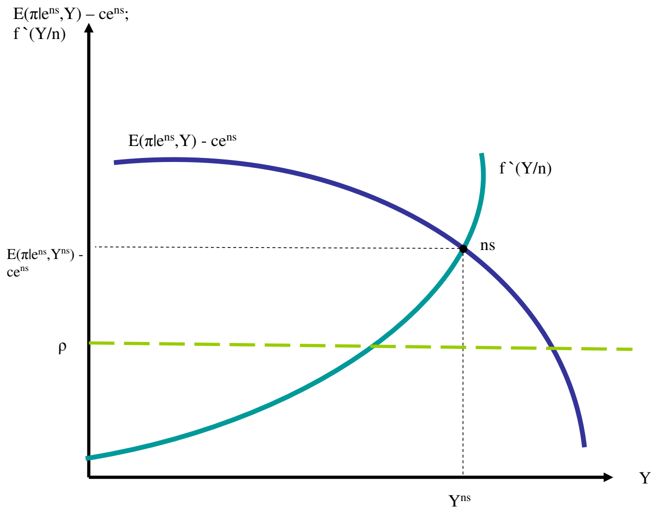

Figure 2.2: Credit market without securitization

Symmetry among competing banks implies that the same level of monitoring and the same amount of lending is chosen. Let $e^{ns} = e_i = e_j$ denote the optimal intensity of monitoring and $I^{ns} = I_i = I_j$ be the optimal amount lent per bank in the no-securitization case. The aggregate bank lending in the economy is $Y^{ns} = nI^{ns}$. In the equilibrium of the credit market Y adjusts so that given its level no individual bank has an incentive to further reduce or increase its supply of credit. This is the case if condition 2.6 is fulfilled:

$$\int_0^L \pi dH(\pi|e^{ns}, Y^{ns}) - ce_i^{ns} = f'(\frac{Y^{ns}}{n}) \tag{2.6}$$

There exists a unique equilibrium, in which Y^{ns} is the aggregate amount of lending and e^{ns} the monitoring intensity banks optimally choose given Y^{ns}.[20]

For levels of $Y < Y^{ns}$ individual banks can increase their expected profits by offering additional credit since expected marginal gross income is greater than the sum of marginal monitoring and funding cost and vice versa. Figure 2.2 depicts the credit market equilibrium.

[20]A proof of the uniqueness is provided in Appendix A.

2.8 Securitization

Now we assess how securitization affects monitoring and the amount of bank lending. Let us consider again a competitive bank i. Like in the previous analysis it chooses the optimal amount of lending I_i and the optimal intensity of monitoring of loans as to maximize its profit. However, now it can fund a portion of the loans through off-balance-sheet funding. Let α_i denote the fraction of loans that are retained, $1-\alpha_i$ are securitized. I allow banks to choose different effort levels for loans which are held until maturity and those which are later securitized. Let a_i denote the monitoring intensity of on-balance-sheet loans and b_i the one for securitized. Let π denote the pay-off per unit of loans that are held until maturity and π^s of later securitized ones. Additionally, let P_i denote bank i's income from issuance of asset-backed securities.

If b_i is observable and verifiable by outsiders, the securitization contract could be written contingent on the effort choice of the banker. Retaining a first loss piece to commit to proper monitoring of loans is not necessary under first best conditions. As already discussed in section 2.4, it is more realistic to assume b_i is private information to the originating bank. Before outlining the effects of the informational asymmetry on incentives and indirectly on the amount of bank lending in more detail, let me briefly characterize the first best case.

2.8.1 The first best case

The bank i chooses how much lending to provide I_i, what fraction of the originated loans to hold to maturity α_i and how intensely to monitor on-balance-sheet and to be securitized loans - a_i and b_i, knowing that investors require an expected gross return of at least ρ to buy asset-backed securities. Its maximization problem is:

$$\max_{a_i,b_i,\alpha_i,I_i} \quad \alpha_i I_i \int_0^L \pi dH(\pi|a_i,Y) - f(I_i - P_i) - c(a_i\alpha_i I_i + b_i(1-\alpha_i)I_i) \quad (2.7)$$

$$s.t.: P_i \leq \frac{1}{\rho}(1-\alpha_i)I_i \int_0^L \pi^s dH(\pi^s|b_i,Y) \quad (2.8)$$

The participation constraint for investors equation 2.8 will always hold with equality at the optimum, so one can substitute for P_i in the objective function 2.7. From the first order conditions with respect to a_i,b_i,α,I_i we get equations 2.9, 2.10, 2.11 and 2.12.[21]

$$a_i = b_i = e_i^{FB} \quad (2.9)$$

$$\int_0^L \pi dH_a(\pi|a_i,Y) = c = \int_0^L \pi^s dH_b(\pi^s|b_i,Y) \quad (2.10)$$

$$f'(I_i - P_i) = \rho, \text{where } P_i = \frac{1}{\rho}(1-\alpha_i)I_i \int_0^L \pi^s dH(\pi^s|b_i,Y) \quad (2.11)$$

$$\int_0^L \pi dH(\pi|a_i,Y) - ca_i = \rho \quad (2.12)$$

The bank chooses α_i so that the overall funding costs are minimized. This is the case if the marginal on-balance-sheet funding costs $f'(I_i - P_i)$ equal the marginal off-balance-sheet funding costs of ρ, as stated in equation 2.11. Sufficient condition for having an interior solution of $\alpha_i \in (0,1)$ is that $f'(I_i^{ns}) > \rho$. This assures that securitizing some of the originated loans would allow banks to reduce their funding costs and thus increase profits. Since $f(0) = 0$ and $f'(0) = 0$, it is never optimal to securitize all loans.

At the optimum the marginal increase in per-unit of lending pay-off induced by more intense monitoring is exactly offset by the surge in per-unit monitoring costs for both type of loans, see equation 2.10. The bank moni-

[21]The exact derivation is presented it in Appendix A.

tors retained and securitized loans with the same intensity of $a_i = b_i = e^{FB}$. The reason is simple: marginally higher monitoring of either loans increases the monitoring costs of the originating bank by the same amount of c. The expected marginal gross income of monitoring is the same, too. Better monitoring of retained loans increases of the expected $t = 1$ period gross income of the bank. Better monitoring of securitized loans leads to a higher expected pay-off to investors. Since they can observe b_i, this translates into a higher willingness to pay for asset-backed securities and thus increases the $t = 0$ issuance income of the bank proportionally. As bank and investors discount expected future playoffs at the same rate of ρ in the optimum, the net present value of an increase in expected $t = 1$ pay-off due to better monitoring of loans held on balance sheets equals exactly the increase in $t = 0$ issuance income due to higher monitoring of securitized loans. It makes no sense to choose different e_i, and so $a_i = b_i = e^{FB}$ is optimal.

The bank originates additional loans as long as the marginal gross income minus induced monitoring costs is higher than the marginal funding costs. In the optimum equation 2.12 must hold.

Again, symmetry among competing banks implies that the same level of monitoring, the same amount of lending and the same fraction of loans to be securitized is chosen. Let e^{FB} denote the optimal intensity of monitoring, I^{FB} be the optimal lending and $(1 - \alpha^{FB})$ be optimal fraction of securitized loans in case effort is observable by outsiders. The total bank lending in the economy is therefore $Y^{FB} = nI^{FB}$. In the equilibrium of the credit market Y must adjust so that given its level no individual bank has an incentive to further reduce or increase its supply of credit. This is the case if condition 2.13 is fulfilled:

$$\int_0^L \pi dH(\pi | e^{FB}, Y^{FB}) - ce^{FB} = \rho \tag{2.13}$$

Again there exists a unique equilibrium, in which Y^{FB} is the aggregate amount of lending and e^{FB} the monitoring intensity banks optimally choose given Y^{FB}.[22] In the end, compared to the situation in which only on-balance-

[22]The uniqueness of the equilibrium can be easily shown by applying the same line of

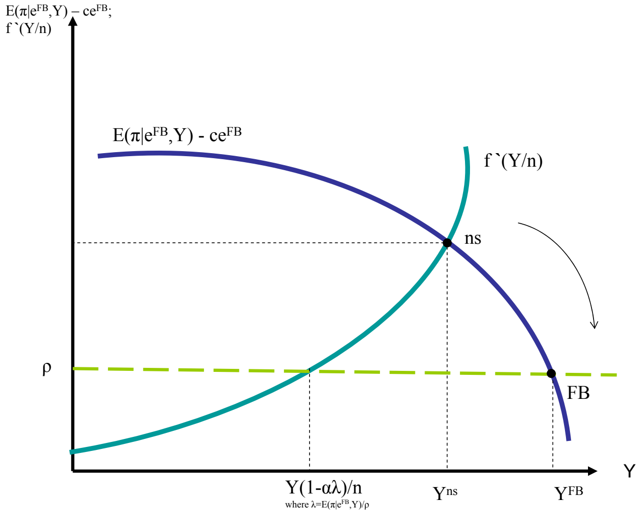

Figure 2.3: Credit market in the first best case

sheet funding of loans is possible, the aggregate amount of lending increases and the funding costs get lower. Figure 2.3 depicts the credit market equilibrium in the first best case.

Securitization of bank loans has the potential capacity to increase the availability of credit in the economy at lower costs and thus to boost welfare. However, so far we did not account for effects of asymmetric information on the monitoring incentives of banks. This is incorporated in the next section.

2.8.2 The second best case

I consider the case of unobservable monitoring effort now. b_i is private information to the bank. Because investors cannot directly observe how well the underlying pool of loans has been monitored, they try to infer b_i from the observables α_i, I_i, R_i. Investors rationally assume that bank i chooses the monitoring intensity as to maximize its own profit given the securitization contract proposed to investors $B(\pi) = min\{\pi, R_i\}$. Bankers in the economy

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argument as in the proof in section A.1.

are aware of it and take it into account. The maximization problem is:

$$\max_{a_i,b_i,\alpha_i,I_i,R_i,P_i} \alpha_i I_i \int_0^L \pi dH(\pi|a_i,Y) + (1-\alpha_i)I_i \int_{R_i}^L (\pi^s - R)dH(\pi^s|b_i,Y) \tag{2.14}$$

$$-f(I_i - P_i) - c(a_i\alpha_i I_i + b_i(1-\alpha_i)I_i)$$

$$s.t.\ P \leq \frac{(1-\alpha_i)I_i}{\rho}[\int_0^{R_i} \pi^s dH(\pi^s|b_i,Y) + \int_{R_i}^L R_i dH(\pi^s|b_i,Y)] \tag{2.15}$$

$$b \in \arg\max_{b_i} \text{ equation 2.14} \tag{2.16}$$

The bank maximizes its expected profit subject to two constraints: the participation constraint for investors equation 2.15 and an incentive constraint 2.16. The incentive constraint captures that, as it chooses α_i, I_i, and R_i, the bank also bears in mind how this affects investors' beliefs for b_i and ultimately their willingness to pay for asset-backed securities. Using the First Order Approach, see Holmström (1979), the incentive constraint can be simplified to:

$$\int_{R_i}^L (\pi^s - R_i)dH_b(\pi^s|b_i,Y) - c = 0 \tag{2.17}$$

Equation 2.17 defines the intensity of monitoring b_i, to which the bank can credibly commit. It depends solely on the retained stake in the securitized assets - measured by R_i: $b_i = b_i^*(R_i)$.[23] The bigger the stake, the better the bank will monitor securitized loans and the higher is investors' anticipation of b_i.[24]

Again the participation constraint will always hold with equality at the optimum, so we can substitute for P_i in the objective function and set up the Lagrangian function. The detailed derivation of the optimally conditions 2.18, 2.19, 2.20, 2.21, and 2.22 is shown in Appendix A.

[23]Solely in the sense that R_i is the only variable the bank directly influences.

[24]Note that in this set-up the lower R is, the higher is the stake retained by the bank. By implicitly differentiating equation 2.17 one can show that decreasing R_i leads to a higher b_i.

$$\int_0^L \pi dH_{a_i}(\pi|a_i, Y) = c \tag{2.18}$$

$$b_i = b_i^*(R_i) \text{ such that } \int_{R_i}^L (\pi^s - R_i)dH_{b_i}(\pi^s|b_i, Y) - c = 0 \tag{2.19}$$

$$\int_0^L \pi dH(\pi|a_i, Y) - ca_i = \int_0^L \pi^s dH(\pi^s|b_i, Y) - cb_i + [\frac{f'(I_i - P_i)}{\rho} - 1]\frac{P_i\rho}{(1-\alpha_i)I_i} \tag{2.20}$$

$$\int_0^L \pi dH(\pi|a_i, Y) - ca_i = f'(I_i - P_i) \tag{2.21}$$

$$(1-\alpha_i)I_i(\frac{f'(I_i - P_i)}{\rho} - 1)\int_{R_i}^L dH(\pi^s|b_i, Y) + f'(I_i - P_i)\frac{\partial P_i}{\partial b_i}\frac{\partial b_i^*(R_i)}{\partial R_i} = 0 \tag{2.22}$$

Proposition 1 *Loans held on the balance sheet of the originating bank are monitored at a higher intensity than securitized loans: $a_i > b_i$, see Innes (1990), Proposition 1. The marginal on-balance-sheet funding costs exceed the off-balance-sheet funding costs: $f'(I_i - P_i) > \rho$. The proofs follow in Appendix A.*

The optimality condition for the monitoring intensity of retained loans, equation 2.18, not surprisingly, is the same as in the first best case. Since for on-balance-sheet loans the originating bank bears all the risk and costs and gets all the returns from prudent monitoring, nothing changes. Though, this does not necessarily imply that same level of a_i is set at the optimum. The marginal expected per-unit return of monitoring in general may depend on the aggregate lending Y_i. To keep the line of argument as simple as possible, I impose the admittedly restrictive assumption that $\frac{\partial^2 E(\pi|e_i, Y)}{\partial e_i \partial Y} = 0$.

Securitized loans are monitored at a lower intensity than retained loans, see Proposition 1. Since banks bear all the cost of monitoring but only part of the downside risks of securitized loans, their monitoring incentives are damaged.

Equation 2.20 determines how many of the originated loans are held until maturity - α_i. Holding more loans, instead of securitizing them, has three effects on profits. First, it increases the expected pay-off from the bank's retained loan portfolio. Second, because less loans are securitized, the expected pay-off from the retained stake in them decreases and the income from issuance of asset-backed securities drops. Third, as the on-balance-sheet funding costs $f'(I_i - P_i)$ are higher than ρ, the overall funding costs rise. At the optimum, the marginal income from holding one more unit of loans on the balance sheet (the left hand side) exactly equals the sum of the foregone marginal benefits: income from retained interest and issuance activity (first two terms on the right hand side), and a possible reduction of funding costs (the third term).

The optimal amount of lending I_i is such that the marginal costs are off-set by the marginal gross income net of induced monitoring, see equation 2.21.[25]

The last optimality condition, stated in equation 2.22, concerns the size of the retained stake R_i. Retaining a smaller stake[26] has two effects. First, incentives for proper monitoring are spoiled, so the intensity of monitoring decreases. This lowers the investors' willingness to pay for asset-backed securities and thus the issuance income of the bank and the expected pay-off from the retained stake. Cost reduction through securitization becomes less effective. This effect is captured by the second term on the left hand side and has a negative sign. Second, holding b_i fixed, a higher R implies issuance of asset-backed securities with a higher par value.[27] This leads to a higher issuance income. This is reflected in the positive first term on the left hand side. Increasing R leads to a higher par value of the senior tranche of asset-backed securities. These, though, are of lower quality. R is optimally chosen

[25]The equation sets marginal cost equal to marginal gross income on retained loans, this also holds securitized loans, as at the optimum marginal gross income from both type of lending is equal.

[26]Which corresponds to a higher R_i.

[27]Or a larger senior tranche.

such that the two effects offset.[28]

I apply the symmetry argument again. All banks in the economy make the same choices. Thus loans originated by different banks are monitored with the same intensity, banks originate the same amount and securitize the same fraction, retaining first loss pieces of the same size. Let a^{SB} denote the optimal intensity of monitoring for retained loans, b^{SB} - the one for securitized loans, I^{SB} be the amount of originated loans and $(1-\alpha^{SB})$ be optimal fraction of assets securitized in case effort is not observable by outsiders. The total lending in the economy is $Y^{SB} = nI^{SB}$. In equilibrium Y^{SB} adjusts so that given its level no bank has an incentive to further increase or reduce its loan supply. This is the case if equation 2.23 is fulfilled:

$$\int_0^L \pi dH(\pi|a^{SB}, Y^{SB}) - ca^{SB} = f'(\frac{Y^{SB}}{n} - P), \tag{2.23}$$

$$\text{where } P = \frac{(1-\alpha)Y^{SB}}{\rho n}[\int_R^L \pi^s dH(\pi^s|b^{SB}, Y^{SB}) + \int_R^L RdH(\pi^s|b^{SB}, Y^{SB})]$$

If $Y < Y^{SB}$ banks originate additional loans, since the marginal gross income minus of monitoring costs exceed the marginal costs of funding. Y increases and drives the marginal gross income down, and the funding and monitoring costs up until condition 2.23 is fulfilled.

2.9 Welfare implications

Securitization techniques allow banks to lower their overall funding costs and provide additional lending. The total amount of credit Y^{SB} is higher compared to the equilibrium amount in the benchmark case of no securitization, although not as high as in the first best case.

However, the additional lending comes at the cost of impaired monitoring incentives for securitized loans. Furthermore, the fraction of securitized loans

[28]Since $R_i \in [0,1]$, there always exists at least one value of R, which maximizes the objective function.

$(1-\alpha^{SB})$ may under circumstances be higher than first best. Proposition 2 states this result.

Proposition 2 *The fraction of securitized loans* $(1-\alpha^{SB})$ *can exceed the one that would emerge if monitoring effort was observable by outsiders,* $(1-\alpha^{FB})$*.*

$$(1-\alpha^{SB}) < \underbrace{\frac{E(\pi|e^{FB}, Y^{FB})}{E(B(\pi^s)|b^{SB}, Y^{SB})}}_{>1}(1-\alpha^{FB}) \tag{2.24}$$

The shaded area in Figure 2.4 denotes this case. The proof follows in Appendix A.

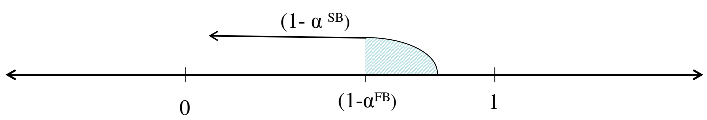
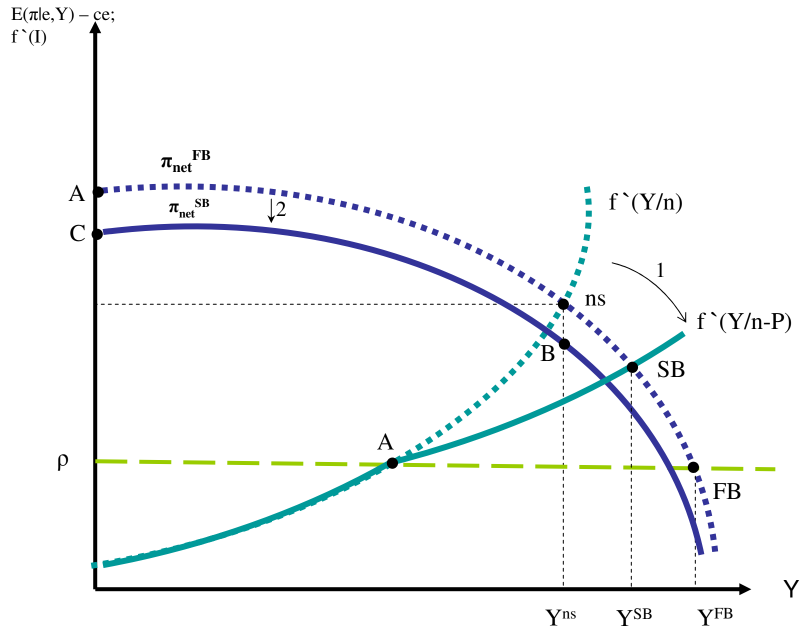


Figure 2.4: Securitized loans in the second best case

Intuitively the result captures the following argument. To generate a certain level of income from issuance of asset-backed securities, a bank has to securitize more loans compared to the first best. The reason is simple. First, under second best circumstances it can only sell a senior tranche and needs to retain a stake and finance it via on-balance-sheet funding. Second, investors anticipate the lower quality of securitized loans. Therefore, their willingness to pay for asset-backed securities is lower compared to the first best case. If the cost reduction opportunities are particularly high compared to the impact of monitoring on the expected return, banks would engage more strongly in securitization.

The trade-off between efficiency gains due to cost reduction and losses out of inefficient monitoring are depicted in Figure 2.5.

Securitization allows banks to reduce their funding costs, see Arrow 1. The welfare increase due to better access to bank credit at lower costs is



Notes: π^{FB}_{net} denotes $E(\pi|a^{FB}, Y) - ca^{FB}$;
π^{SB}_{net} denotes $\alpha\left(E(\pi|a^{SB}, Y) - ca^{SB}\right) + (1-\alpha)\left(E(\pi|b^{SB}, Y) - cb^{SB}\right)$

Figure 2.5: Credit market in the second best case

marked by the triangular area A(SB)(ns). It reflects the change in the sum of bank profits and consumer surplus of borrowers, as competition induces banks to pass the lower funding costs to them. We do not need to take into account how investors in asset-backed securities are affected since banks extract all their rents.

The average quality of originated loans, however, is inefficiently low due to the impaired monitoring incentives. Arrow 2 captures this effect. Securitized loans are less carefully evaluated and therefore the average marginal returns to capital in the economy are inefficiently low.[29] The area ACB(ns) indicates this inefficiency.

The cost reduction effect of securitization outweighs the effect of ineffi-

[29]Note that $e^{ns} = e^{FB} = a^{SB} > b^{SB}$. Arrow 2 therefore shows the decline in the average quality of loans in the second best case compared to the no securitization case, or similarly to the first best case. The average quality of loans in the second best is measured via the weighted average of the pay-off of securitized and retained loans $E(\alpha\pi + (1-\alpha)\pi^s)$. Would the Figure further include the locus for $E(\pi|b^{SB}, Y) - cb^{SB}$, it would be located under the π^{SB}_{net}-line.

cient monitoring in this framework. Compared to the no securitization case, the outcome is constrained optimal. The inefficient monitoring of securitized loans is correctly anticipated by investors and feeds into lower issuances income of banks. Therefore banks take it indirectly into account in their maximization problem. Securitization may not lead to the first best outcome but it improves the capital allocation: funds that would otherwise be used to finance investment projects yielding the reservation return of ρ are channeled to more profitable ones, although not as profitable as they would be if efficiently monitored.

2.10 Discussion of results and some policy implications

The two assumptions driving the result are:

- Investors correctly anticipate b^{SB}
- Securitization allows a reduction of the funding costs

In this section I briefly discuss how the results would change if these assumptions are relaxed starting with the assumption of rational expectations of investors.

Let us assume for the time being, that the issued asset-backed securities are complex and investors in the economy are not sophisticated enough to correctly anticipate b^{SB}. Overestimation of the profitability of asset-backed securities by investors leads to a welfare loss. As investors expect a unrealistically high pay-off from asset-backed securities, their willingness to pay is biased upwards. This has two compounding effects on bank lending. First, banks no longer fully internalize the effect of less stringent monitoring as it does not fully translate into lower prices for asset-backed securities. Therefore, incentives for diligent monitoring become even weaker than they are in the second best case. Therefore securitized loans would be even less efficiently monitored.

Second, a systematical overvaluation of asset-backed securities effectively implies that investors accept securities which deliver a return lower than their reservation return ρ. Banks are tempted to originate and securitize excessively as asset-backed securities are easily sold at prices above fair value. In this scenario resources are mis-allocated away from more profitable investment projects into poorly monitored and thus badly performing securitized assets.

Any additional frictions which lead to investors not being able or willing to assess the risk and profitability of assets can produce outcomes similar to one described above. For instance investors relying heavily on the opinion of rating agencies, who may benefit from labeling those securities less risky than they actually are, see Ashcraft and Schuermann (2008). They provide a detailed overview of the numerous interlinked frictions arising in the mortgage securitization process.

The second driving assumption is that the on-balance-sheet funding costs $f(I)$ can and do exceed the reservation return of investors for high values of I. I argue that minimum capital adequacy regulation of banks forces them to fund loans to a higher extent via equity than they would choose themselves and therefore raises the funding costs of banks relative to the costs of other non-bank institutions.[30] Implicitly assumed is that, besides the negative impact on costs, the regulation does not have any positive impact on the economy.

Securitization allows banks to partially circumvent regulation and supply additional credit at lower costs to borrowers. The additional lending though comes at the cost of impaired monitoring incentives. We are in the second best constrained optimum. In this framework the first best outcome can be achieved if banking is deregulated. The funding costs of banks would equal ρ, no securitization would take place and thus all loans would be funded at the low cost of ρ **and** monitored at the optimal intensity.

[30]Pennacchi (1980) shows how the tax disadvantage of equity makes it more "expensive" compared with debt. He furthermore shows, based on a bank's profit maximization problem that capital regulation indeed harms the profitability of banks.

I would like to emphasise that the model is not meant to be used to derive policy recommendations with regard to capital adequacy regulation of banks. For simplicity of the argument I omit some basic features of banks that make capital adequacy regulation desirable.[31] For instance, banks fund long-term, illiquid assets by issuing short-term demand deposits. Deposits are held by many dispersed small depositors and thus coordination between agents is difficult. This makes them vulnerable to panics and can lead to bank runs. Explicit deposit insurance systems and emergency liquidity provision of modern central banks help remedy this problem. However, as deposit insurance and lender of last resort provision insulate banks from runs and thus reduce the risk of bankruptcy, banks have incentives to engage in too risky activities. Regulation, including capital adequacy guidelines, attempts to remedy the arising moral hazard and thus improves the overall efficiency of banking.

Since my aim is to study the effects of securitization on the quantity and quality of originated bank loans, I have chosen the simplest possible way of modeling a banking institution. To deduct any policy recommendations regarding the design and efficiency of capital adequacy regulation of banks, one has to consider the effects of deposit insurance and central bank emergency assistance on banks's incentives.[32]

If we agree for the time being that capital adequacy regulation of banks is desirable, another relevant question is whether it is desirable to leave investors in asset-backed securities and the securitization process unregulated. If investors have the necessary skills to carefully evaluate risks and are fully liable for possible losses, nothing speaks against leaving them unregulated. As they exert due diligence, the economy ends up in the constrained second best case and welfare improves. If not, however, combinations of agency problems on the side of originators and investors can lead to highly inefficient outcomes and justifies more stringent regulation. In a similar vein, any

[31]See Dewatripont and Tirole (1994), chapter 2.2, and Freixas and Rochet (1998), chapter 9 for an overview.

[32]The implicit government support of banks considered to be "too-big-to-fail" undermines incentives too.

rules and regulations aiming at a reduction of the complexity and opacity of asset-backed securities facilitating their valuation, are welfare enhancing.

2.11 Conclusion

I introduce a simple pricipal-agent framework for the analysis of the effect of securitization on bank lending. Securitization allows banks to reduce their funding costs. However, it also impairs banks' incentives for diligent monitoring. Bank lending in the economy increases at the cost of inefficient monotoring of, possibly too many, securitized loans. Overall welfare is improved as the cost reduction due to securitization in the framework outweighs the adverse effects of inefficient monitoring. However, securitization may lead to substantial welfare losses and mis-allocate funds away from more profitable investment projects to poorly underwritten and thus badly performing securitized assets, if additional frictions impair the willingness or ability of investors to adequately price asset-backed securities.

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A Appendix to chapter 2

A.1 Proof of the uniqueness of the equilibrium in Section 2.7

Proof. For the equilibrium to be unique it is sufficient that a) the left hand side of equation 4 is strictly decreasing in Y, where as b) the right hand side is strictly increasing in Y. If that is the case there exists no more than one value for Y, for which the right hand side equals the left one. Because of the assumed strictly convex on-balance-sheet cost function, the condition b) is fulfilled by assumption. What we need to show now is that the condition a) is fulfilled. This is a little bit more tricky because a variation of Y influences the left hand side in two ways. First of all an increase of Y leads to a lower expected pay-off per unit, so the value of the integral becomes smaller. Additionally however, this also has indirect effects as the optimal monitoring intensity e^{ns} by banks generally may depend on Y. One can show that the indirect effect is not important by totally differentiating the left hand side .

$$d\left(\int_0^L \pi dH(\pi|e^{ns}, Y) - ce_i\right) = \tag{2.25}$$
$$\left(\int_0^L \pi dH_Y(\pi|e^{ns}, Y)\right) dY + \left(\int_0^L \pi dH_{e^{ns}}(\pi|e^{ns}, Y) - c\right) \frac{\partial e^{ns}}{\partial Y} dY$$

The indirect effect disappears since for each level of Y, e^{ns} is such that $\int_0^L \pi dH_{e_i}(\pi|e_i, Y) = c$ holds. Thus the only term that matters is the one capturing the negative direct effect and the l.h.s. of equation 2.6 is indeed a decreasing function of Y. ■

A.2 Derivation of the optimality conditions for the observable effort choice

To simplify the notation, I suppress all subscripts i in the below derivation.

$$\max_{a,b,\alpha,I} \ \alpha I \int_0^L \pi dH(\pi|a,Y) - f(I-P) - c(a\alpha I + b(1-\alpha)I) \tag{2.26}$$
$$where \ P = \frac{1}{\rho}(1-\alpha)I \int_0^L \pi^s dH(\pi^s|b,Y)$$

The first order conditions with respect to a, b, α, I respectively give us:

$$\frac{\partial .}{\partial a} = 0 \Rightarrow \int_0^L \pi dH_a(\pi|a,Y) = c \tag{2.27}$$

$$\frac{\partial .}{\partial b} = 0 \Rightarrow \frac{f'(I-P)}{\rho} \int_0^L \pi^s dH_b(\pi^s|b,Y) = c \tag{2.28}$$

$$\frac{\partial .}{\partial \alpha} = 0 \Rightarrow \int_0^L \pi dH(\pi|a,Y) - ca = \frac{f'(I-P)}{\rho} \int_0^L \pi^s dH(\pi^s|b,Y) - cb \tag{2.29}$$

$$\frac{\partial .}{\partial I} = 0 \Rightarrow \tag{2.30}$$
$$\alpha[\int_0^L \pi dH(\pi|a,Y) - ca] + (1-\alpha)[\frac{f'(I-P)}{\rho} \int_0^L \pi^s dH(\pi^s|b,Y) - cb] = f'(I-P)$$

Substituting for c in in the left hand side of equation 2.29 from equation 2.27 and in the right hand side from equation 2.28 we get:

$$E(\pi|a,Y) - a\frac{\partial E(\pi|a,Y)}{\partial a} = \frac{f'(I-P)}{\rho}\left(E(\pi|b,Y) - b\frac{\partial E(\pi|b,Y)}{\partial b}\right), \tag{2.31}$$

, where I use the shorter expression $E(\pi|.,Y)$ instead of $\int_0^L \pi dH(\pi|.,Y)$. Rearranging the equation gives us:

$$\frac{E(\pi|a,Y) - a\frac{\partial E(\pi|a,Y)}{\partial a}}{E(\pi|b,Y) - b\frac{\partial E(\pi|b,Y)}{\partial b}} = \frac{f'(I-P)}{\rho}, \tag{2.32}$$

Now it is easy to show that it can never be optimal to choose $a \neq b$.

Proof.

By $E(\pi|e,Y)$ being monotone increasing and concave in e, the function $E(\pi|e,Y) - e\frac{\partial E(\pi|e,Y)}{\partial e}$ is non-negative and strictly increasing in e, see the Lemma at the end of this section.

Proof by contradiction:

Suppose $a > b$ is optimal. Than the nominator in the left hand side of 2.32 is greater than the denominator. Therefore $f(I-P) > \rho$.

From $a > b$ and the strict concavity of $E(\pi|e,Y)$ follows that:

$$\frac{\partial E(\pi|a,Y)}{\partial a} < \frac{\partial E(\pi^s|b,Y)}{\partial b} \tag{2.33}$$

Further from $f(I-P) > \rho$ follows:

$$\frac{\partial E(\pi^s|b,Y)}{\partial b} < \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b} \tag{2.34}$$

Combining inequalities 2.33 and 2.34 we get $\frac{\partial E(\pi|a,Y)}{\partial a} < \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b}$.

According to the FOC with respect to a and b, equations 2.27 and 2.28, $\frac{E(\pi|a,Y)}{\partial a} = c = \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b}$. We have a contradiction, thus $a > b$ cannot be optimal.

Analogically, suppose $a < b$ is optimal.

Than the nominator in the left hand side of 2.32 is smaller than the denominator. Therefore at the optimum $f(I-P) < \rho$.

From $a < b$ and the strict concavity of $E(\pi|e,Y)$ follows:
$\frac{\partial E(\pi|a,Y)}{\partial a} > \frac{\partial E(\pi^s|b,Y)}{\partial b}$.

Further from $f(I-P) < \rho$ follows: $\frac{\partial E(\pi^s|b,Y)}{\partial b} > \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b}$.

Combining the two inequalities gives us:
$\frac{\partial E(\pi|a,Y)}{\partial a} > \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b}$.

According to the FOC with respect to a and b, equations 2.27 and 2.28, $\frac{E(\pi|a,Y)}{\partial a} = c = \frac{f'(I-P)}{\rho}\frac{\partial E(\pi^s|b,Y)}{\partial b}$. We have a contradiction, thus $a < b$ cannot be optimal.

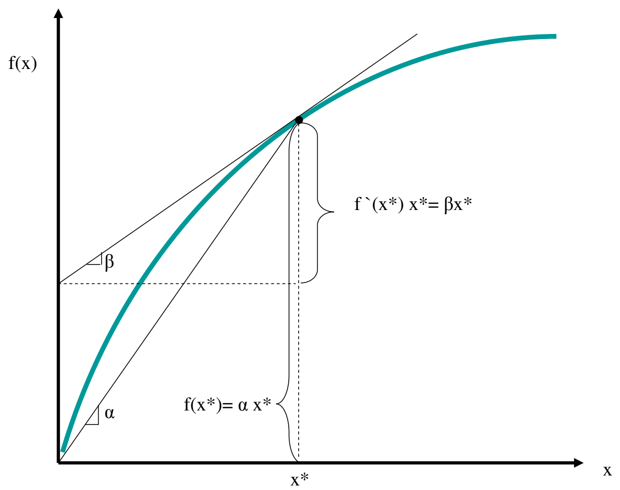
Thus $a = b = e^{FB}$ ■

Using $a = b$ and equations 2.29 and 2.32 gives us that $f(I-P) = \rho$.

Using $f(I-P) = \rho$ in equation 2.30 we get $\int_0^L \pi dH(\pi|e^{FB}, Y) - ce^{FB} = \rho$.

Lemma 3 *If $f(x)$ is monotone increasing and concave, than $f(x) - f`(x)x$ is positive and increasing.*

Proof. Differentiating the expression $f(x) - f`(x)x$ with respect to x gives us $-f``(x)x$. By the concavity of $f(x)$ , $-f``(x)x$ is positive. Thus $f(x) - f`(x)x$ is an increasing function. The Figure below demonstrates graphically that $f(x) - f`(x)x$ is positive.



■

A.3 The second best case

$$\max_{a,b,\alpha,I,R} \alpha I \int_0^L \pi dH(\pi|a,Y) + (1-\alpha)I \int_R^L (\pi^s - R)dH(\pi^s|b,Y)$$
$$-f(I-P) - c(a\alpha I + b(1-\alpha)I) \tag{2.35}$$
$$s.t.\ P \leq \frac{(1-\alpha)I}{\rho}[\int_0^R \pi^s dH(\pi^s|b,Y) + \int_R^L RdH(\pi^s|b,Y)] \tag{2.36}$$
$$\int_R^L (\pi^s - R)dH_b(\pi^s|b,Y) - c = 0 \tag{2.37}$$

The incentive constraint equation 2.37 gives us b as an implicit function of R: $b = b^*(R)$. I use this implicit function representation of the incentive constraint from now on.

The participation constraint for investors equation 2.36 holds with equality at the optimum, so P can be inserted in the objective function. The Lagrangian is:

$$\max_{a,\, b,\, \alpha,\, I,\, R,\, \lambda} \alpha I \int_0^L \pi dH(\pi|a,Y) + (1-\alpha)I \int_R^L (\pi^s - R) dH(\pi^s|b,Y)$$
$$-f(I-P) - c(a\alpha I + b(1-\alpha)I) - \lambda[b - b^*(R)] \qquad (2.38)$$
$$where\ P = \frac{(1-\alpha)I}{\rho}[\int_0^R \pi^s dH(\pi^s|b,Y) + \int_R^L R dH(\pi^s|b,Y)] \qquad (2.39)$$

From the FOC w.r.t. a we get:

$$\int_0^L \pi dH_a(\pi|a,Y) = c \qquad (2.40)$$

From the FOC w.r.t. λ we get:

$$b = b^*(R) \ \Rightarrow \int_R^L (\pi^s - R) dH_b(\pi^s|b,Y) - c = 0 \qquad (2.41)$$

From the FOC w.r.t. b we get:

$$(1-\alpha)I[\int_R^L (\pi^s - R) dH_b(\pi^s|b,Y) - c] + f'(I-P)\frac{\partial P}{\partial b} - \lambda = 0 \qquad (2.42)$$

Using 2.41 and rearranging we get:

$$\lambda = f'(I-P)\frac{\partial P}{\partial b} \qquad (2.43)$$

From the FOC w.r.t. α we get:

$$I[\int_0^L \pi dH(\pi|a,Y) - ca] - I[\int_R^L (\pi^s - R) dH(\pi^s|b,Y) - cb] + f'(I-P)\frac{\partial P}{\partial \alpha} = 0 \qquad (2.44)$$

Using that $\frac{\partial P}{\partial \alpha} = -\frac{I}{\rho}[\int_0^R \pi^s dH(\pi^s|b,Y) + \int_R^L R dH(\pi^s|b,Y)]$, see equation 2.39, and rearranging we get:

$$\int_0^L \pi dH(\pi|a,Y) - ca = \int_0^L \pi^s dH(\pi^s|b,Y) - cb + [\frac{f'(I-P)}{\rho} - 1]\frac{P\rho}{(1-\alpha)I} \tag{2.45}$$

From the FOC w.r.t. I we get:

$$\begin{aligned} \alpha[\int_0^L \pi dH(\pi|a,Y) - ca] + (1-\alpha)\{\int_0^L \pi^s dH(\pi^s|b,Y) - cb \\ +[\frac{f'(I-P)}{\rho} - 1]\frac{P\rho}{(1-\alpha)I}\} - f'(I-P) = 0 \end{aligned} \tag{2.46}$$

Using the equation 2.45 and rearranging we get:

$$\int_0^L \pi dH(\pi|a,Y) - ca = f'(I-P) \tag{2.47}$$

or equivalently:

$$\int_0^L \pi^s dH(\pi^s|b,Y) - cb + [\frac{f'(I-P)}{\rho} - 1]\frac{P\rho}{(1-\alpha)I} = f'(I-P) \tag{2.48}$$

From the FOC w.r.t. R we get:

$$\begin{aligned} (1-\alpha)I\{-[(\pi - R)f(\pi^s|b,Y)]_{\pi=R} - \int_R^L dH(\pi^s|b,Y)\} \\ +\frac{f'(I-P)(1-\alpha)I}{\rho}\{[\pi^s f(\pi^s|b,Y)]_{\pi^s=R} - [Rf(\pi^s|b,Y)]_{\pi^s=R} + \int_R^L dH(\pi^s|b,Y)\} \\ +\lambda\frac{\partial b^*(R)}{\partial R} = 0 \end{aligned} \tag{2.49}$$

Rearranging and substituting for λ from equation 2.43 we get:

$$(1-\alpha)I(\frac{f'(I-P)}{\rho} - 1)\int_R^L dH(\pi^s|b,Y) + f'(I-P)\frac{\partial P}{\partial b}\frac{\partial b^*(R)}{\partial R} = 0 \tag{2.50}$$

Proof of Proposition 1

Proof. The first statement of Lemma 1, $a > b$, is directly implied by Innes (1990), page 56, Proposition 1. Below, I restate his proof using my notation for completeness.

As implied by equation 2.16, b is chosen as to maximize:[33]

$$\int_R^L (\pi^s - R)h(\pi^s|b,Y)d\pi^s - cb \tag{2.51}$$

all other terms of the objective function do not depend on b and are therefore suppressed in the outline.

I slightly rearrange the term:

$$\int_R^L (\pi^s - R)h(\pi^s|b,Y)d\pi^s - cb \tag{2.52}$$
$$= \int_0^L \pi^s h(\pi^s|b,Y)d\pi^s - \left(\int_0^R \pi^s h(\pi^s|b,Y)d\pi^s + R\int_R^L h(\pi^s|b,Y)d\pi^s\right) - cb$$

Integration by parts of the first integral in parentheses and using that $\int_0^L h(\pi^s|b,Y)d\pi^s = 1$[34] gives us:

$$\int_0^L \pi^s h(\pi^s|b,Y)d\pi^s - ([\pi^s H(\pi^s|b,Y)]_0^R - \int_0^R H(\pi^s|b,Y)d\pi^s + R(1 - H(R|b,Y))) - cb \tag{2.53}$$
$$= \int_0^L \pi^s h(\pi^s|b,Y)d\pi^s - \left(R - \int_0^R H(\pi^s|b,Y)d\pi^s\right) - cb$$

Banks set b is so that
$$\frac{\partial\left(\int_0^L \pi^s h(\pi^s|b,Y)d\pi^s - \left(R - \int_0^R H(\pi^s|b,Y)d\pi^s\right) - cb\right)}{\partial b} = 0 \Rightarrow$$

$$\int_0^L \pi^s h_b(\pi^s|b,Y)d\pi^s - b + \int_0^R H_b(\pi^s|b,Y)d\pi^s = 0 \tag{2.54}$$

The last term on the left hand side of equation 2.54 is negative, implied

[33]Here I use the longer notation of $h(\pi|b,Y)d\pi$ instead of $dH(\pi|b,Y)$.
[34]Property of any probability density function

by the monotone likelihood ratio property of $h(\pi|e,Y)$ with respect to e.

If b were equal to the optimal level of monitoring a^{SB} on-balance-sheet loans get, then $\int_0^L \pi^s h_b(\pi^s|b,Y)d\pi^s - b$ would equal 0. Since $E(\pi^s|b,Y)$ is concave in b, the term $\int_0^L \pi^s h_b(\pi^s|b,Y)d\pi^s - b$ is positive for $b < a^{SB}$, and negative in the opposite case. Thus for $b > a^{SB}$ the left hand side of equation 2.54 is strictly negative. Any value of b that solves equation 2.54 must be lower than a^{SB}.

To show that $f\prime(I-P) > \rho$ is much easier. The function $\int_0^L \pi dH(\pi|e,Y) - ce$ attains its maximum for $e = a^{SB}$, see 2.18. So for any level $e \neq a^{SB}$, including b^{SB}, its value is strictly lower than this maximum. The optimality condition for α is: $\int_0^L \pi dH(\pi|a,Y) - ca = \int_0^L \pi^s dH(\pi^s|b,Y) - cb + [\frac{f'(I-P)}{\rho} - 1]\frac{P\rho}{(1-\alpha)I}$. To be fulfilled, the term $[\frac{f'(I-P)}{\rho} - 1]\frac{P\rho}{(1-\alpha)I}$ must be positive. This is the case if $f\prime(I-P) > \rho$. ■

A.4 Proof of Proposition 2

Proof. Proposition 1 and equation 2.11 imply that

$$f'(I^{SB} - P^{SB}) > \rho = f'(I^{FB} - P^{FB})$$

From the convexity of $f(.)$ follows

$$I^{SB} - P^{SB} > I^{FB} - P^{FB}.$$

Using the equilibrium condition that $I^j = \frac{Y^j}{n}$, for $j = \{SB, FB\}$ and the exact values for P^{SB}, P^{FB} as stated in equations 2.39, 2.11 we get:[35]

$$\frac{Y^{SB}}{n}\left(1 - \frac{(1-\alpha^{SB})}{\rho}E(B(\pi^s)|b^{SB},Y^{SB}))\right) > \frac{Y^{FB}}{n}\left(1 - \frac{(1-\alpha^{FB})}{\rho}E(\pi|e^{FB},Y^{FB})\right).$$

[35] Here I use $E(B(\pi^s)|b^{SB},Y^{SB})$ instead of the longer expression $\int_0^R \pi^s dH(\pi^s|b^{SB},Y^{SB}) + \int_R^L RdH(\pi^s|b^{SB},Y^{SB})$.

Since $Y^{SB} < Y^{FB}$ we get

$$1 - (1 - \alpha^{SB})E(B(\pi^s)|b^{SB}, Y^{SB}) > 1 - (1 - \alpha^{FB})E(\pi|e^{FB}, Y^{FB}).$$

Simplifying the inequality leads to the following condition:

$$\frac{(1 - \alpha^{SB})}{(1 - \alpha^{FB})} < \frac{E(\pi|e^{FB}, Y^{FB})}{E(B(\pi^s)|b^{SB}, Y^{SB})} \tag{2.55}$$

It can never be the case in optimum that $E(B(\pi^s)|b^{SB}, Y^{SB}) > \rho$. Otherwise any bank i would find it profitable to originate an additional loan of size one unit, retain the first loss piece and sell the senior tranche $B(\pi^s)$. The issuance income of this would be strictly higher than the unit it originally lent and it would cover its monitoring costs out of the future proceeds of the retained stake. Additional origination would increase profits and would be undertaken until it is no longer profitable. Thus the right hand side of equation 2.55 is strictly greater than one, as $E(\pi|e^{FB}, Y^{FB}) = \rho + ca^{FB} > E(B(\pi^s)|b^{SB}, Y^{SB})$. ■

Chapter 3

The empirics of securitization by banks: Determinants and incentive effects[1]

[1]This chapter is based on a joint work with Ivan Andreev.

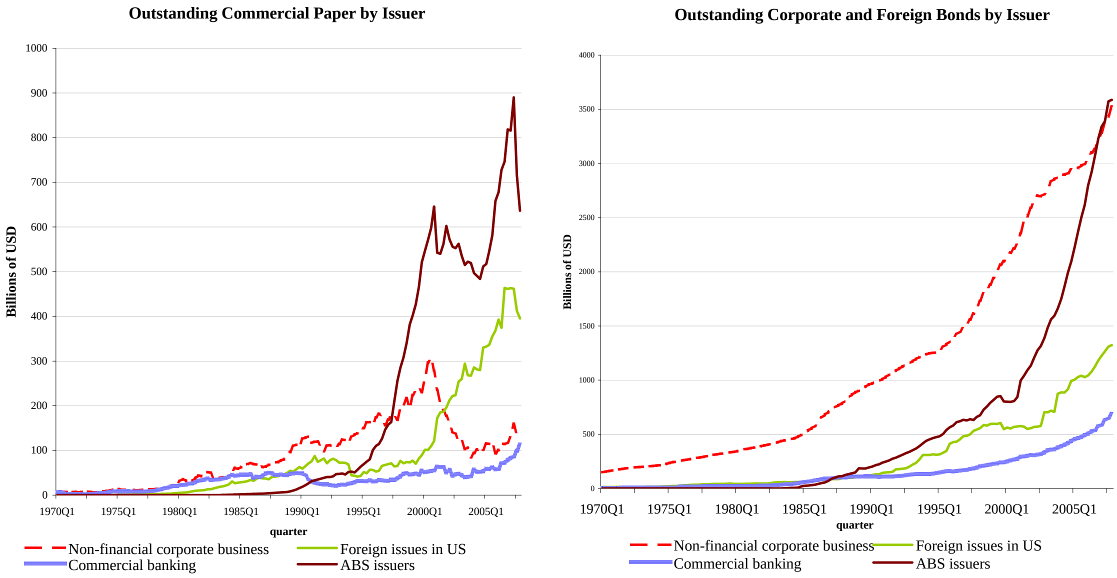
The empirics of securitization by banks

3.1 Introduction

Between 2000 and 2007 the market for asset-backed securities was one of the largest and fastest-growing segments in the fixed-income securities market. Despite its size and the vibrant issuance activity, it attracted the attention of policy makers, researchers, and the general public only after the onset of the current crisis. Figure 3.1 depicts the evolution of the outstanding amount of asset-backed securities in the US compared with securities issued by non-financial corporations, commercial banks, and foreign issuers. Between 2000 and 2007 the segment of asset-backed commercial paper was the largest one in short-term debt markets. With regard to longer-term debt, depicted in the right panel, the amount of asset-backed securities outstanding experienced a remarkable growth until mid-2007. By the end of the year it had become larger than the outstanding amount of non-financial corporate bonds.

With the benefit of hindsight, it is apparent that the observed surge in securitization activity had been accompanied by poor underwriting standards and the origination of riskier credit. Defaults on those risky financial claims led to losses accruing to the investors in asset-backed securities and triggered a global financial crisis. Right now asset-backed securities are still called by some "toxic waste" assets. Exploring why securitization takes place, particularly whether it is solely driven by attempts to circumvent capital adequacy regulation and whether it leads to unsound bank lending and excessive risk taking, can help us understand better the observed development. Furthermore, it can help in improving the regulation of capital markets to foster the resilience of the financial system. Therefore, the questions we address in this paper, focusing on the banking sector, are: why do banks securitize loans and does securitization affect the incentives of banks for prudent screening and monitoring of borrowers.

Securitization can be broadly defined as the transformation of illiquid financial claims into tradable securities; see Greenbaum and Thackor (1987). The central feature of securitization is that it allows assets to be removed from the balance sheet of the institution that originated them onto the balance sheet of a special trust company. For these assets the bank is no longer



Notes: Author's calculations using data from the Flow of Funds Statistics for the US.

Figure 3.1: Evolution of the amount outstanding of securitized assets in the US during the period 1970-2007

required to hold regulatory capital. Theory gives us roughly two views on why banks may choose to securitize assets: on the one hand, for instance, Allen and Carletti (2006), Allen and Gale (2007), and Cerasi and Rochet (2008) see securitization as a largely beneficial financial innovation that allows a better allocation of risk, lowers the distress costs for the issuer, and (see Arping (2004) or Chiesa (2008)) leads to better incentives for monitoring. On the other hand, there is a more pessimistic view of securitization as being largely driven by attempts to circumvent capital regulation and impairing incentives; see for instance Gorton and Pennacchi (1995) and Fecht and Wagner (2007).

Our empirical results confirm the latter view. Using panel data on large US banks we find evidence of the existence of a regulatory arbitrage motive in securitization. The novel feature of our analysis is the introduction of a corrected measure for the tier 1 capital to total assets and total regulatory capital to risk-weighted assets ratios. In most empirical studies regressions of the issuance activity of banks on their leverage and a set of controls are performed; see for instance Minton et al. (2004) and Bannier and Hänsel

(2008). Such studies find that the probability of securitizing rather decreases as leverage ratios increase, implying that banks with a high capital basis tend to securitize more often than capital-constrained banks. The finding contradicts the regulatory arbitrage hypothesis, according to which banks with low capital available to back additional lending benefit the most from securitization. They can seize new profitable lending opportunities without having to issue new equity or build it up slowly via retained earnings, thus one would expect that securitization rather becomes more probable as leverage grows. The approach of Minton et al. (2004) is problematic because the observed leverage ratios are endogenous. If banks use securitization to circumvent capital regulation, they will structure the transactions so that the ex-post observable leverage in their balance sheet is lowered.

We propose a different approach: instead of using observable but endogenous capital ratios we construct a proxy for the unobservable counterfactual capital ratio. It allows us to capture the effect of capital on securitization but cuts the reverse influence of securitization on capital adequacy. We argue that by doing so we use the variable actually relevant to the decision to securitize: namely, how high the disclosed ratio would have been if the assets were, instead of being securitized, retained on the balance sheet. Banks with low counterfactual capital ratios benefit from securitization, as they are able to remove assets from their balance sheet and free capital to back new loans. As a result, the standard capital ratios do not appear low any more. Looking at the extensive margin of securitization we find that a low counterfactual capital ratio, measured either via the tier 1 capital to total assets or the total regulatory capital to risk-weighted assets ratios, increases the probability of securitizing. Further, we focus on the sample of securitizing banks only and shed light on banks' decision on how many assets to securitize. We find evidence that capital arbitrage is an important determinant of the intensive margin of securitization too. Furthermore, our empirical results show that banks facing higher costs of on-balance-sheet debt financing will use securitization techniques on a larger scale. This finding is consistent with the efficient risk-sharing view of securitization.

Next, we investigate how securitization affects the quality of securitized loans. Currently, there is relatively little literature on that topic. We assess the effects of securitization by comparing the ex-post observed delinquencies on loans of the same type during the same quarter originated by the same institution that are securitized with those retained. The observed higher delinquencies we interpret as evidence of adverse effects of securitization on incentives for monitoring or adverse selection of loans by originators. We also analyze how commonly used techniques for overcoming such incentive problems - the retention of a subordinated stake in securitized assets - affect the delinquencies of securitized loans. The results suggest that such techniques are not successful in reducing moral hazard or adverse selection problems in securitization. Rather the amount of bank capital at originating institutions influences significantly positively the quality of originated and securitized loans.

In a way our research indicates that capital adequacy regulation is a double-edged sword: whereas loopholes in the regulatory framework can seduce banks to securitize assets just for the sake of not having to hold regulatory capital, sufficient levels of capital do give banks the right incentives for prudent behavior.

The rest of the paper is organized as follows. Section 3.2 provides a review of the related theoretical and empirical literature. The subsequent section provides a brief look at our data set. Section 3.4 describes the potential determinants of securitization activity. In sections 3.5 and 3.6 we present our empirical models on the extensive and intensive margins of securitization. The estimation strategy and results are presented too. Section 3.7 looks at the incentive effects of securitization. Finally, section 3.8 concludes.

3.2 Related literature

The theoretical literature on credit risk transfer and securitization can be traced back to Greenbaum and Thakor's "Bank funding modes", published in 1987 in the *Journal of Banking and Finance*. They analyze why banks choose to fund assets via securitization versus the traditional issuance of deposits in an adverse selection framework. Greenbaum and Thakor (1987) emphasize the role of bank regulation and the advancing information processing technology. In the equilibrium of their model banks hold riskier assets and securitize the "good" ones. The subsequent literature can be roughly divided into two main strands. The first one explores the scope for risk sharing between the banking sector and other sectors in the economy as well as its effects on the stability of banks and possible contagion. The second one puts more emphasis on the implications for monitoring of loan applicants and the quality of originated loans. Those two strands are intrinsically linked. Risk sharing via securitization insulates banks from losses, and in a world with asymmetric information and limited liability, alters incentives to prevent defaults. Thus, any beneficial effect from risk transfer from the arguably more vulnerable banking sector to other sectors in the economy will be attenuated by the adverse effect on monitoring incentives. Additionally, incentive problems in securitization can lead to the origination of bad loans and thus can undermine the safety and soundness of banks if part of the risks are retained by the originator or banks themselves invest in asset-backed securities.

Let us very briefly summarize the most recent theoretical and empirical contributions, starting with the theoretical papers on risk sharing and its effects on the financial system stability. In Allen and Gale (2007) banks securitize assets to circumvent capital regulation. They show that inefficiently high capital adequacy requirements for banks induce credit risk transfer to a hypothetical insurance sector. The link between the two sectors gives rise to systemic risk: problems in the insurance sector can spread to the banking industry. Based on an augmented version of this model, Allen and Carletti (2006) focus on the interaction between idiosyncratic liquidity shocks and credit risk transfer to create contagion. In their model securitization is truly driven by risk-sharing considerations. Risk sharing is desirable because the sectors engage in activities with imperfectly correlated returns. Credit risk transfer, though, induces insurers to hold a long-term security, which otherwise is held by banks only. Contagion arises because bad outcomes for insurance companies force them to sell the long security. This in turn harms banks hit by adverse liquidity shocks as they use the long security to refinance in the interbank market. Depressed prices of the long security do not allow them to collect the necessary resources to pay out depositors and lead to bankruptcies.[2] In all those models banks do not perform screening and monitoring of borrowers; the emphasis lies rather on the implications for the stability of individual banks and arising contagion effects.

One of the first papers to focus on incentives is the work of Gorton and Pennacchi (1995). The authors stress the adverse effect of securitization on the quality of originated loans. Banks selling a proportional claim on loans do not bear the full loss if those loans default and, therefore, their incentives for borrower monitoring are distorted. In a recent paper Fecht and Wagner (2007) show that securitization remedies the hold-up problem between bank managers and shareholders, which ceteris paribus allows a safer capital structure with a higher equity share. Securitization can therefore potentially improve stability. However, because rents collected by managers are lower, their incentives to monitor borrowers are damaged. On the contrary, Chiesa (2008) shows that securitization can lead to better incentives for monitoring. The result arises in a framework of banks prone to gamble on a good economic outlook instead of stringently screening whom to grant a loan. Securitization alleviates the incentives for gambling and induces banks to exert monitoring effort. Arping (2004) demonstrates that securitization can have a beneficial effect on the incentives of borrowers without impairing the monitoring by lenders. In his framework securitization facilitates the ex-post enforcement of the debt contract between borrower and lender. Finally, Cerasi and Rochet (2008) show that loan sales and credit derivatives can provide optimal insurance to banks without impairing incentives.

The existing theoretical literature, while giving a consistent prediction that securitization leads to contagion effects, is rather inconclusive on both why banks securitize and whether this leads to the origination of bad loans. This is the starting point for our empirical analysis. There are several empirical studies on the determinants of securitization and only a few on the incentive issues.

[2]Wagner and Marsh (2006) follow a very similar line of research.

With regard to the determinants of securitization, most studies cannot find evidence of a capital arbitrage motive. For instance Minton et al. (2004) use data on US financial firms, among others banks, in the period 1993-2002. They show that unregulated finance companies and investment banks are more likely to securitize than regulated commercial banks, which they interpret as evidence against the regulatory capital arbitrage view. Focusing on banks only they find that banks with higher capital ratios are more likely to securitize, which again confirms the previous result. Very similar is the empirical study of Bannier and Hänsel (2008), suggesting that there is little or no evidence of capital arbitrage in securitization. They use data on collateralized loan obligations (CLO) issued by large European banks during the period 1997-2004. Throughout most of the specifications the capital ratios seem to have no significant impact on the probability of securitizing. The only exception is a fixed-effects logit specification based on a restricted sample of listed institutions only. Bannier and Hänsel (2008) conclude that securitization is mainly used as an efficient funding tool, especially for banks with high credit risk and low liquidity, which reduces the overall costs of financing. Gorton and Souleles (2006) and Martin-Oliver and Saurina (2007) also do not support capital arbitrage as a driving motive for securitization but rather suggest that liquidity needs or lower debt funding costs are the main drivers. Contrary to most of the literature, Calomiris and Mason (2004) find that circumventing regulation is motivating banks to securitize assets. Focusing on credit card debt securitizations of US commercial banks, they find evidence that the desire to reach lower levels of capital than the regulatory requirement is a driving motive. Finally, Dionne and Harchaoui (2003) study the relationship between bank capital, securitization, and credit risk using Canadian bank data. One result of their analysis is that securitization is negatively related to capital ratios.

The empirical literature on incentive problems in securitization is somehow scarcer. In a recent paper Keys et al. (2010) ask whether securitization impairs the incentives of financial firms to screen borrowers properly based on US data on securitized subprime mortgages. They use the fact that mortgages given to borrowers with a creditworthiness measured by the FICO scores[3] of 620 and above are easily securitized whereas mortgages granted to borrowers with a FICO of 619 or lower remain on the balance sheet of the originator with a very high probability.[4] Originators take this into account at the time mortgages are granted and, therefore, may screen more carefully loan applicants with a FICO of 619 or lower. Indeed, Keys et al. (2010) find that securitized loans with a FICO of 619 perform ex post better than those with a FICO of 621. Hence, securitization has adverse effects on the screening incentives of loan originators. Dell' Ariccia et al. (2008) and Mian and Sufi (2009) also provide some evidence of poor screening due to securitization using loan-level data for sub-prime mortgages, even though this is not the main focus of their work. Both studies find that denial rates on loan applications are lower in regions in which a bigger fraction of mortgages were securitized and interpret it as evidence that lending standards deteriorate due to securitization.

Our study adds to both strands of the empirical literature. With regard to identifying a capital arbitrage motive in securitization we propose a corrected version of the standard capital ratios used in empirical works that does not suffer from endogeneity. Using the proposed corrected capital ratios we find evidence of capital arbitrage. Additionally to giving evidence of poor incentives for borrower screening, we show how bank characteristics and the amount of provided credit enhancements relate to the quality of securitized loans. Our results suggest that a sufficient level of bank capital rather than the retention of a first-loss piece gives banks the right incentives and leads to the origination of better quality loans.

3.3 Data and summary statistics

The data come from the Uniform Bank Performance Report, collected by the Federal Deposit Insurance Corporation[5], and cover the period starting

[3]Fair Isaac Credit Score. A greater value of the FICO score indicates lower credit risk.

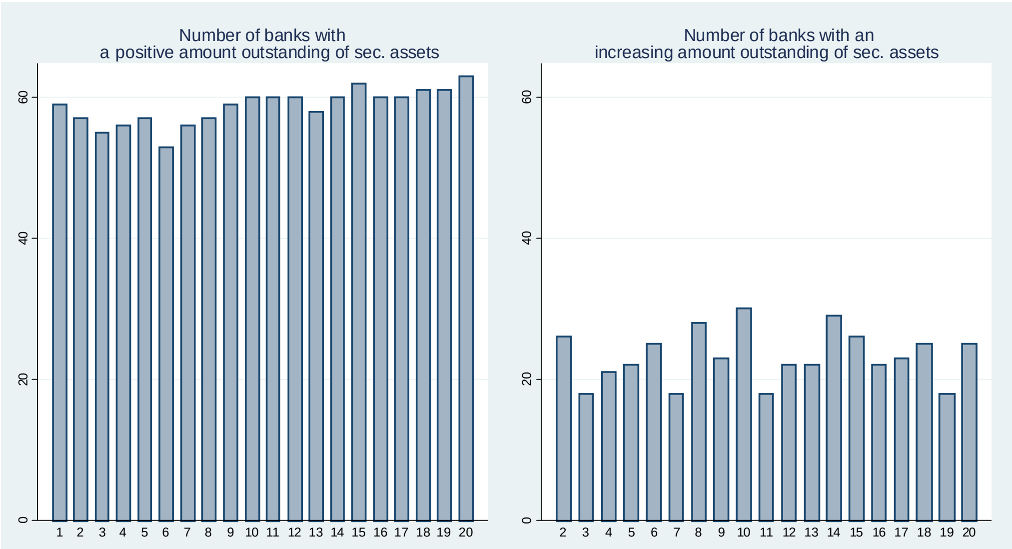
[4]This threshold arises due to regulation constraints. Ginnie Mae and Fannie Mae generally do not accept such mortgages.

[5]The data is available at the Federal Financial Institutions Examination Council webpage at `www.ffiec.gov/ubpr.htm`.

in the third quarter of 2003 to the second quarter of 2008. It contains the income statements and balance sheet statements, data on regulatory capital and risk-weighted assets, securitization activities, past due loans and leases, and off-balance-sheet exposure. In the second quarter of 2008 a total of 7622 banking institutions insured by the FDIC were operating. For our analysis of the determinants of securitization we concentrate on the activities of big commercial banks with assets of more than 1 billion US dollars and the credit card specialty banks in the United States. This leaves us with a cross-sectional dimension of our panel of 506 banks. We are aware that we concentrate on a group of banks that may be systematically different from smaller banks. Nevertheless, we believe that this is the relevant sample for our purposes since securitization activity decreases sharply with the size of institutions. Among the 186 banks with assets of more than $3 billion in the second quarter of 2008 approximately 33% have securitized assets at least once during the period. Looking at the 297 banks with assets between $1 billion and $3 billion, we observe less than 5% active banks. If we consider the peer group of even smaller banks with assets of more than $0.3 billion but less than $1 billion the share of banks that participate in securitization drops even further to around 2.5%. Given that bigger banks also securitize bigger pools of assets, we believe that we cover most of the actual securitization activities of commercial banks in the United States. In our analysis we also include FDIC insured banks specializing in credit card loans. We restrict our attention to private label securitization activities only. We do not analyze securitization transactions settled via the Government Sponsored Enterprises. Our data sample covers approximately 83% of banking assets and 42% of securitized assets backing outstanding private label asset-backed securities[6] in the fourth quarter of 2007.

Regarding the question of whether securitization leads to incentive problems, we have a sample of 110 banks that reported past dues and losses for both their securitized assets and those retained on the balance sheet.

[6]Asset-backed securities in the sense of our analysis include all the securities issued in a securitization transaction, which are backed by financial claims to third parties. These include MBS, CDO, CLO, etc.



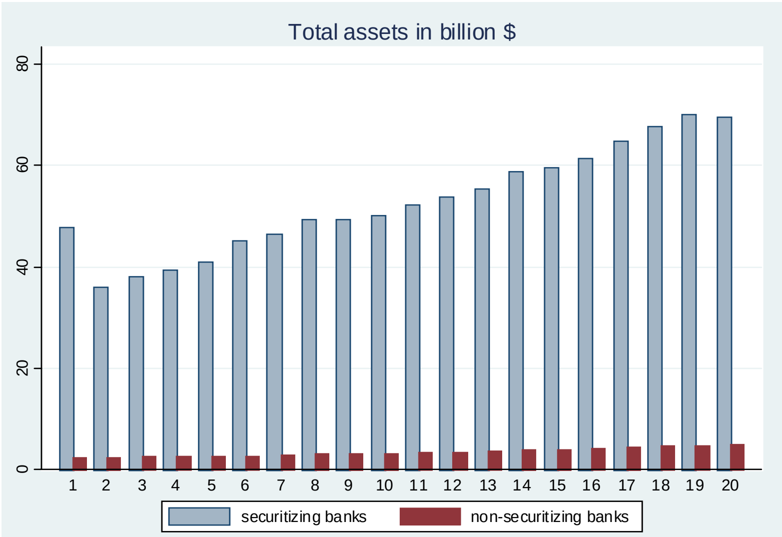
Notes: Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008.

Figure 3.2: Number of banks reporting securitization activity during the quarters

Let us have a first look at the data. Out of the total 506 banks 86 have securitized assets at least once during the period; 83% of the banks in the sample are never-securitizers. The left panel of Figure 3.2 reveals that in every single quarter a relatively constant number of around 60 banks reported a positive amount outstanding of securitized assets. Reporting a positive amount outstanding of securitized assets does not necessarily imply that the bank has been involved in new securitization activities. Assets that have been securitized in previous periods and have not matured yet are part of the reported volume. In the right panel of Figure 3.2 we depict the number of banks whose reported outstanding securitized assets have increased during the quarter. These banks engaged in new securitization activities definitely. However, this measure of issuance activity slightly underestimates the frequency of new securitization activity by banks,[7] as the amount of maturing assets plus the amount charged off due to defaults may be larger than the amount of assets that were securitized during a quarter.

In the next Figure 3.3 we contrast the size of banks that have never

[7]And certainly the volume of newly securitized assets.



Notes: Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008.

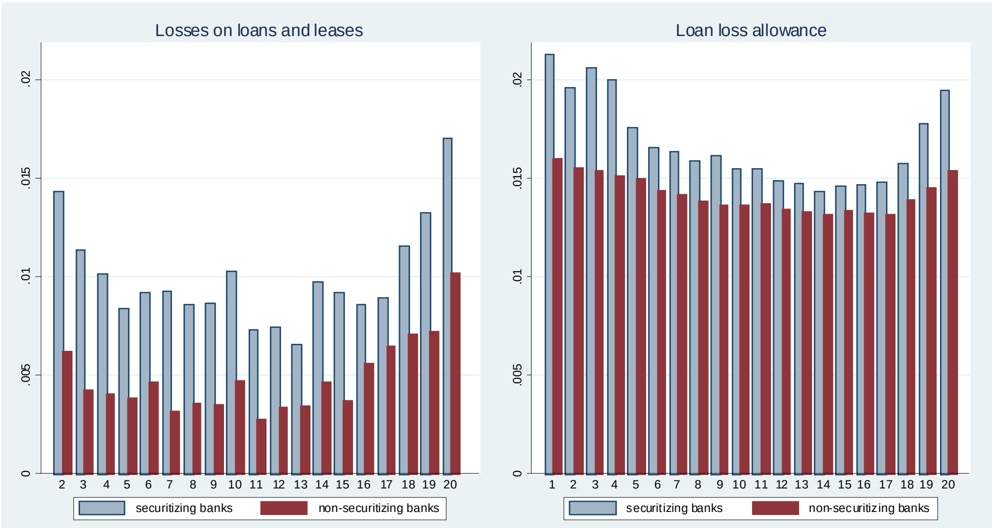
Figure 3.3: Bank size

securitized with the size of banks that have securitized assets at least once. Active banks were significantly bigger and were able to increase their size more quickly during the relevant period. The difference in size is remarkable given that we choose to concentrate on big banks only.

Securitizing banks seem to engage in more risky lending activities or operate in more risky segments of the credit market. Figure 3.4 depicts that securitizing banks have been experiencing considerably higher losses on their on-balance-sheet loans and leases throughout the period. Against the higher expected losses they also hold higher loan loss reserves on average.

Those riskier lending practices, though, appear to be profitable. The lower-left panel of Figure 3.5 shows that the yields on loans and leases realized by securitizing banks are slightly better than those of non-securitizers.

The overall profitability of securitizers is higher too; see the difference in the average return on assets in the upper-left panel of Figure 3.5. It can be largely explained by the higher non-interest income those banks generate, including income from securitization and servicing activities. Comparing the returns on equity, in the upper-right panel, the finding is slightly different. Securitizers do not perform better throughout the whole period; since the



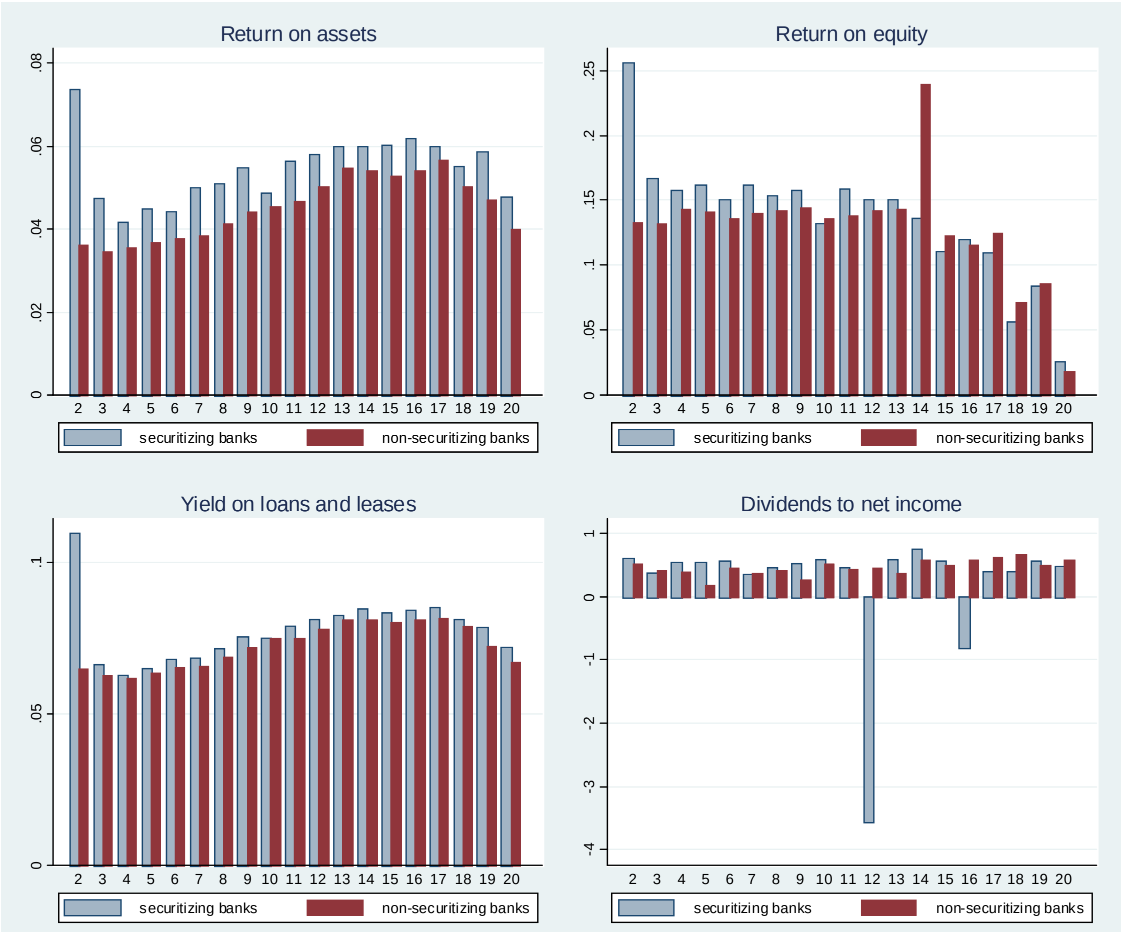
Notes: The figure shows losses and loss allowances as a ratio to total loans and leases. Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008.

Figure 3.4: Credit risk

last quarter of 2006 the return on equity of non-securitizers has been higher on average.

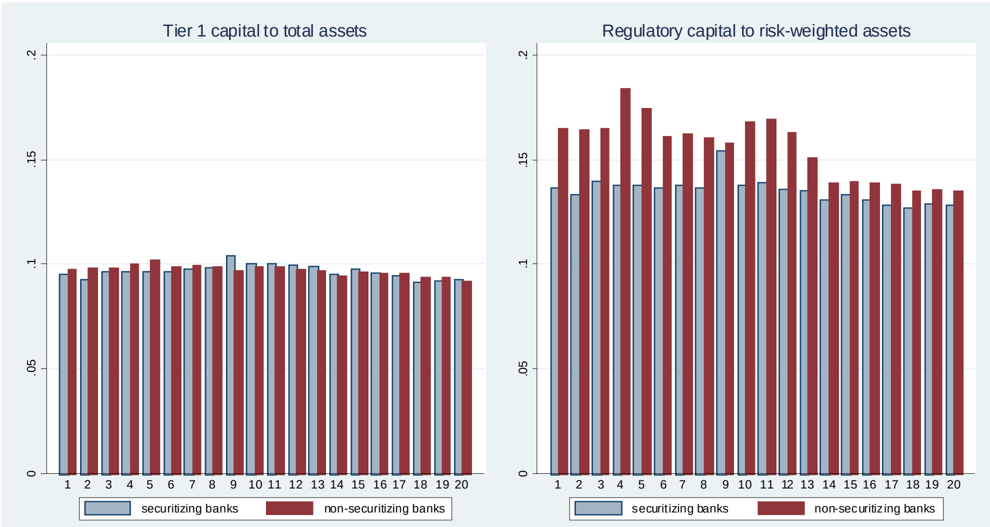
The lower-right panel of Figure 3.5 shows the ratio of dividends to profits. Up until the third quarter of 2007 securitizing banks paid out a larger fraction of net income. The two big negative outliers in the second quarter of 2006 and the second quarter of 2007 arise because banks that had booked losses nevertheless paid dividends. Since the onset of the crisis this pattern has changed: in three out of the four quarters since mid-2007 non-securitizers payed a higher fraction of net income to shareholders.

In Figure 3.6 we compare the regulatory capital ratios of banks. Banks in the United States are required to hold sufficient capital to maintain both a ratio of tier 1 capital to total assets of at least 4% and a ratio of total risk-based capital to risk-weighted assets of at least 8%. There are no systematical differences in the tier 1 capital ratio shown in the left panel of Figure 3.6. The ratio of regulatory capital to risk-weighted assets, however, is substantially higher for non-securitizing banks up until the end of 2006. During the last 7 quarters of the period, the difference in regulatory capital has become smaller; nevertheless, it remains positive in the data.



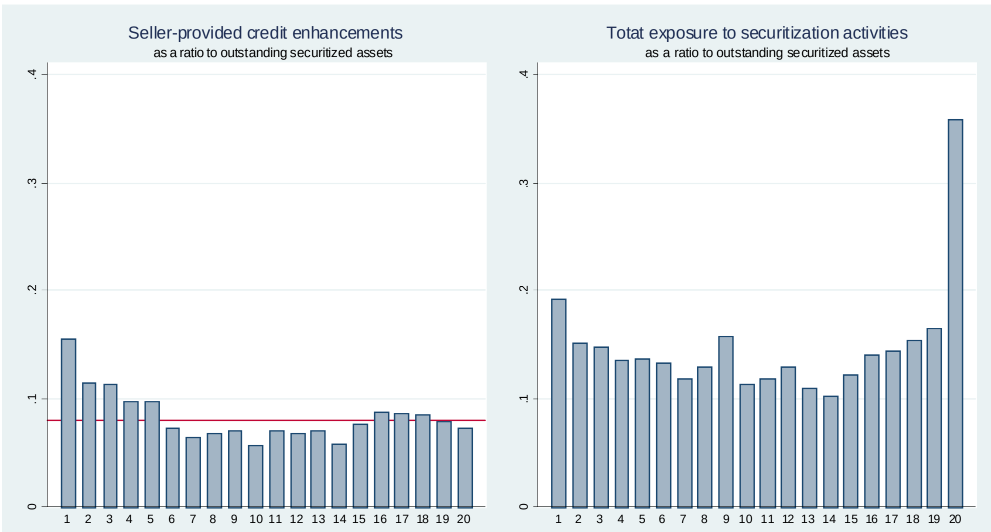
Notes: Quarters denoted on the horizontal axis. 2 is the fourth quarter of 2003; 20 is the second quarter of 2008.

Figure 3.5: Bank profitability



Notes: Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008.

Figure 3.6: Regulatory capital ratios



Notes: Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008. The horizontal line marks the 8% threshold.

Figure 3.7: Securitization exposure

The aim of securitization is the transfer of a significant part of the risk associated with the underlying pool of assets. Banks, though, retain some of the risk in the form of a subordinated claim, that serves as a credit enhancement, or as a pro-rata share of the issued asset-backed securities. The left panel of Figure 3.7 shows us how much credit enhancement banks provided to their securitized assets. On average such enhancements amount to around 8 percent of the outstanding securitized assets.[8] In the right panel we depict the total of subordinated claims and retained ownership[9] in securitized assets. The total exposure to securitization as a percentage of the amount outstanding of securitized assets seems to decrease very slowly up to the first quarter of 2007 and increases quite sharply in the course of the crisis. The extreme peak in the second quarter of 2008 is most probably due to banks providing support to previously securitized assets.[10]

3.4 Determinants of securitization activity

The observed securitization activity is an equilibrium outcome, determined by both demand- and supply-side factors. The main aim of our analysis is to

[8]Interesting is the significant drop in seller-provided credit enhancements from the third quarter of 2003 to the second quarter of 2004. The regulation regarding the treatment of securitization exposures in calculating the regulatory capital ratios was changed in January 2002, see Federal Register (2001). The new rule obliged banks to hold one dollar of bank capital against each dollar of outstanding retained subordinated claims. The previous regulation had limited the maximal capital charge to the minimum of either the retained subordinated stake or the capital the bank would have had to maintain, had it, instead of securitizing those assets, left them on the balance sheet. Under the old regulation a bank that securitized a pool of f.e. consumer credit of \$100 and retained a subordinated claim of size \$10 had to hold only \$8 of capital against the pool, whereas under the new rule the capital charge increases to \$10 - the size of the subordinated claim. This may have made it no longer profitable for banks to retain a large subordinated exposure to securitized assets. The data on seller-provided credit enhancements in 2003 partially capture the structure of older securitizations. The retained credit enhancements starting from the last quarter of 2004 to the second quarter of 2007 amounted to less than 8% of the amount outstanding of securitized assets and thus indeed allowed a lower capital charge.

[9]The so-called retained seller's interest, which does not provide any credit enhancement and carries a pro-rata share of the risk.

[10]We provide disaggregated data on the seller-provided credit enhancements by type of securitized loans in Figure 3.9 of Appendix B.

identify the factors affecting the decision of banks to securitize assets. Thus, we focus on the supply of asset-backed securities by credit institutions in the baseline analysis, while controlling for possible changes in demand over time by using quarter dummies. According to theory, there are two main drivers: risk-sharing considerations[11] and the possibility of gaining regulatory capital relief via securitization.[12] Additionally, securitization may allow banks to fund assets at more favorable debt costs. This is the so-called "efficient contracting view". The transfer of the ownership of the underlying assets to a special purpose vehicle removes them from the bankruptcy estate of the originating institution.[13] Thus, investors in asset-backed securities do not bear the risk of bankruptcy of the bank itself, but only risks associated with the performance of the underlying assets.[14] We also account for economy of scale and scope effects and a possible self-selection into securitization of more profitable banks.

To complement our analysis, we also try to identify demand-side effects by including a set of macroeconomic variables capturing investors' risk appetite and the monetary policy stance. We follow a purely empirical strategy, as performed in the literature for instance by Minton et al. (2004) and Bannier and Hänsel (2008), among others.

These are our working hypotheses:

- **Regulatory capital relief**: The "regulatory capital arbitrage" hypothesis calls for a negative relationship between capital ratios and securitization activity.[15] Capital constrained banks will use securitization techniques in order to improve their disclosed regulatory capital ratios. There are two challenges for the econometric identification of this causal relationship. First, banks will not wait until the regulatory

[11] See Allen and Carletti (2006) and Wagner and Marsh (2006).

[12] See for instance Allen and Gale (2007).

[13] The securitized assets are not part of the bank's bankruptcy estate and thus investors in asset-backed securities continue to receive the interest and principle payments even in the case it becomes bankrupt. Special purpose vehicle are structured in a way that makes it impossible to become insolvent. See Schwarcz (1994).

[14] See for instance Calomiris and Mason (2004) and Gorton and Souleles (2006).

[15] See Duffie and Garleanu (2001) and Calomiris and Mason (2004) among others.

constraint becomes binding. We believe that they act in a forward-looking manner and use the techniques preemptively. Second, if banks are successful in circumventing capital regulation, the *ex-post* observed capital ratio should not appear low any more. We argue that using such ex-post observed capital ratios in the regression analysis, as performed in the existing literature, is misleading and propose a different approach: we use a proxy of the unobservable counterfactual capital adequacy ratio. Since this is a departure from the existing literature, let us explain our idea in some detail.

Consider a credit institution, which intends to use securitization for capital relief purposes. Let us assume that it would like to originate new loans, but by doing so it risks becoming capital constrained. To prevent this from happening, it can securitize part of its loans. Suppose that it has risk-weighted assets Y_{t-1} and regulatory capital C_{t-1} and expects to grant new loans $\Delta Y_t > 0$. Without the use of securitization, its regulatory capital ratio in period t would be lower, equal to $\frac{C_{t-1}}{Y_{t-1}+\Delta Y_t}$, and possibly leave no buffer to the regulatory threshold. Let Z_t denote the amount of assets to be securitized and z_t the size of the first-loss piece. After the assets have been securitized, the capital ratio changes to:[16]

$$\frac{C_{t-1} - z_t}{Y_{t-1} + \Delta Y_t - Z_t} \tag{3.1}$$

If the term z_t/Z_t is lower than $C_{t-1}/(Y_{t-1} + \Delta Y_t)$, securitization activities will *improve* the ratio. This is probably why people find a positive relationship between securitization and capital adequacy. However, this is not the casual link from capital constraints to securitization. We generally do not observe how low capital ratios would have been if securitization had not taken place. The observed capital ratio suffers from endogeneity: a low capital ratio induces banks to securitize assets

[16]The regulatory rules, see Federal Register (2001), for securitization state that the first-loss piece must be deducted from capital for regulatory purposes; therefore, the numerator decreases. As the securitized assets Z_t are no longer on the balance sheet of the bank, the denominator decreases too.

but once securitization has taken place, capital ratios do not appear low any more. We construct a proxy for the counterfactual capital ratio by putting the securitized assets back on the balance sheet and adding the retained credit enhancements z_t to the regulatory capital. Intuitively, we focus on how low capital levels affect the decision to securitize by suppressing the positive effect of securitization on capital adequacy. In this manner we are able to solve the reverse causality from securitization back to the observed capital ratio.[17]

Since the capital adequacy regulation in the USA imposes two restrictions, we construct the counterfactual proxies for the two minimum capital ratios required: a *Capital/RWA*, defined as the regulatory total risk-based capital as a share of risk-weighted assets, and *Tier1/Total Assets*, defined as the tier 1 capital to total assets.[18]

Table 3.10 in Appendix B reports the mean of the “original” and the “corrected” capital ratios.[19] Since those do not differ for non-participating institutions, we should compare the means calculated for the subsample of securitizers who were active at least once during the sample period. On average the corrected measure is about 1% lower than the standard one.

- **Risk sharing**: If securitization is used to transfer risk from the bank to outside investors, we would expect higher risk to be associated with a higher probability of securitizing. To capture this idea we use the variable *loss allowances*. The variable controls for credit risk as perceived

[17] A similar approach is followed by Calomiris and Mason (2004). They use a ratio of capital to the sum of on-balance-sheet and securitized assets, but do not take into account the size of the first-loss piece in the numerator.

[18] We have data on the amount outstanding of provided credit enhancement at period t and the amount outstanding of securitized assets by type. We calculate the counterfactual Tier1/Total Assets ratio by adding the amount of credit enhancements to tier 1 capital and the amount of securitized assets to total assets; for the Capital/RWA ratio we again add the provided credit enhancements to the total capital for regulatory purposes and add the risk-weighted securitized assets to the risk-weighted assets. For weights we use 0.50 for mortgages and home equity loans and 1 for other loans, as required for assets held on the balance sheet of banks.

[19] In addition Table 3.8 in Appendix B provides a pairwise correlation matrix for these capital ratios.

by the bank. It is measured as the ratio of the allowances for future loan and lease losses to total loans and lease-financing receivables.

- **Financing costs**: Securitization can be used as an efficient tool for lowering the debt financing costs. The interest and principal payments to investors in asset-backed securities are not affected in the event of the bankruptcy of the originator. Consequently, the financing costs by issuing asset-backed securities do not include a premium for this risk. We use the *average costs of bank debt* (including subordinated notes and debentures) as a measure of financing costs. The more costly debt financing is for individual institutions, the higher the probability of securitizing should be.

- **Economies of scope**: Securitization comprises activities similar to investment banking. The key steps in the securitization process - pooling the underlying assets, underwriting the securities, and placing them on the market - require expertise that is very similar to the one acquired in investment banking. Therefore, potential synergy effects arise. To capture this idea we use the variable *investment banking* measured as investment banking income to total income. We expect that the more strongly involved a bank is in investment banking, the higher the probability of securitizing.

- **Economies of scale**: Since there are substantial fixed costs for setting up a special purpose vehicle, we expect bigger banks that securitize bigger loan pools to experience lower average costs of securitization. We capture this idea by using the *total assets* as the measure of bank size and expect a positive relationship.

- **Profitability**: Securitization may be more easily feasible for more profitable banks, as they possibly can afford to pay the high up-front fixed costs[20] of issuing asset-backed securities. Hence, there might be some

[20]These are for example administrative and legal costs for setting up a SPV as well as rating agency fees.

sort of "selection" of more profitable banks into securitization. To capture this idea we use the *yield on loans and leases* as our measure of profitability. More profitable banks become more likely securitizers.[21]

- **Average tax rate**: Financing through securitization has the disadvantage of non-deductibility of costs from the pre-tax income compared with on-balance-sheet debt finance.[22] Thus, we expect banks with high effective tax rates to be less likely to securitize assets. The variable *average tax rate* is defined as applicable income taxes as a share of the pre-tax net operating income.

We now turn to the possible demand factors. Two macroeconomic variables are included:

- **Fed funds rate**: A low level of interest rates and high money supply might induce investors to search for more profitable investment opportunities, among others in asset-backed securities. For that reason we expect a negative sign here.

- **Baa risk premium**: We want to capture the overall risk appetite of investors. The Baa risk premium is calculated as the difference between the yield on corporate bonds with a Baa rating and the yield on 10-year government bonds.[23] We expect a lower risk premium to be associated with a higher demand for asset-backed securities.

We concentrate on two main questions. The first one asks why do (or do not) banks securitize assets? Here we try to identify systematic differences between the groups of securitizers and non-securitizers, which relate to this decision. We call this the *extensive margin* of securitization. The second question we ask is why some banks securitize more than other banks. Here we identify differences between banks within the group of securitizers relating

[21]Previous studies use return on equity as a measure of profitability. However, this measure is likely to be endogenous, because securitization itself directly influences the return on equity via increased non-interest income.

[22]See Minton et al. (2004).

[23]We obtain the data from the web page of the Board of the Governors of the Federal Reserve System, `http://www.federalreserve.gov`.

to the scale of securitization activity, calling it the *intensive margin*. Let us first turn our attention to the extensive margin.

3.5 The extensive margin of securitization

We start with the standard binary choice model, which can be derived from the following latent variable model. Let $\Delta\pi$ denote the unobservable change in expected discounted profits if a bank chooses to securitize assets.[24] We assume that it is a linear function of observables:

$$\Delta\pi = \boldsymbol{x}\boldsymbol{\beta} + \epsilon \tag{3.2}$$

where $\boldsymbol{x}$ represents the row vector of determinants of securitization (including a constant), $\boldsymbol{\beta}$ is the column vector of coefficients, and ϵ is a random error term. Let s be a binary choice variable, equaling 1 if the bank securitizes assets during the quarter and 0 otherwise.

A profit-maximizing bank participates in securitization if $\Delta\pi > 0$. Hence, the probability of securitizing is given by:[25]

$$\begin{aligned} P(s = 1|\boldsymbol{x}) = P(\Delta\pi > 0|\boldsymbol{x}) = P(\boldsymbol{x}\boldsymbol{\beta} + \epsilon > 0|\boldsymbol{x}) = \\ = P(\epsilon > -\boldsymbol{x}\boldsymbol{\beta}|\boldsymbol{x}) = 1 - G(-\boldsymbol{x}\boldsymbol{\beta}) = G(\boldsymbol{x}\boldsymbol{\beta}) \end{aligned} \tag{3.3}$$

where $G(.)$ is the cumulative distribution function of ϵ. We further assume that $G(.)$ is the standard normal cumulative distribution function, which leads to the probit model.

We estimate the model by maximum likelihood. The log likelihood function for a sample of N banks observed over T periods is given by:

[24] We use the term profits even though this could stand for any benefits to stakeholders, managers, or other decision makers that cannot be expressed monetarily.

[25] Here we assume that the distribution of ϵ is symmetric, with a mean of zero.

$$L(\boldsymbol{\beta}) = \sum_{i=1}^{N}\sum_{t=1}^{T}\{s_{it}ln\left[G(\boldsymbol{x}_{it}\boldsymbol{\beta})\right] + (1-s_{it})ln\left[1-G(\boldsymbol{x}_{it}\boldsymbol{\beta})\right]\} \tag{3.4}$$

To account for a possible serial correlation within panel units and heteroskedasticity across panels, we use a cluster-robust variance-covariance estimator, with banks as cluster units.[26]

Before outlining the estimation results, let us briefly explain how we generate the left-hand side variable. The most natural way to proceed would be to define an active bank, $s_{it} = 1$, if we observe new issuance of asset-backed securities by bank i in quarter t, as performed for instance by Minton et al. (2004) or Bannier and Hänsel (2008). Unfortunately, we have data on the amount outstanding of securitized assets only. Given the available data we can choose among three strategies:

- treat banks as participating in every period if we observe a positive amount outstanding of securitized assets at least once. This strategy is suitable for identifying determinants that do not depend on the particular time period, like the relative size difference of securitizers vs. non-securitizers as visible in Figure 3.3. However, it does not allow us to find factors accounting for the dynamics of the decision of banks to securitize over time, as their status as securitizer would not depend on issuance in any particular period.

- treat banks as participating in period t if we observe a positive amount outstanding of securitized assets. This approach has a drawback: observing a positive outstanding amount does not necessarily imply that

[26]The alternative strategy would have been to use a random effects probit estimator. This specification deals with serial autocorrelation in the composite error term due to the presence of an unobserved random effect. More specifically, it assumes that the autocorrelation of the error terms is equal at all lags. We decided to use a pooled probit estimator with corrected standard errors because Monte Carlo studies, for instance Guilkey and Murphy (1993), suggest that it performs as well as the computationally intensive random effects probit estimator. It is further recommended as, first, one does not have to assume equicorrelated error terms and, second, if there is another form of clustering on the bank level in our data, inference based on the random effects estimates would be misleading.

new issuance has occurred. Bank loans typically have a maturity of more than one quarter, therefore, a positive amount outstanding can be observed even though no new assets were securitized. Thus, some institutions, which were not active at time t, will be misclassified as securitizers.

- treat banks as participating at time t only if we observe an increasing amount outstanding of securitized assets. Even though this approach captures new issuance more accurately, it has a similar drawback to the previous strategy. Whereas observing an increase implies that new issuance has occurred, it is possible that the amount outstanding of securitized assets decreases despite the issuance of asset-backed securities during the period if the newly issued amount is lower than the amount of previously securitized loans maturing during the quarter. Thus, some institutions, that issued new asset-backed securities will be misclassified as non-participating.

Since we would like to capture the possible dynamics in banks' securitization activity, we consider the second and third options. Both strategies lead to a non-classical measurement error in the left-hand side variable. We believe that the misclassification is only minor if we use the latter one and treat banks as participating at time t if we observe an increase in the amount outstanding of the securitized assets. The misclassification biases coefficients downward in absolute value but preserves their signs.[27] Thus, we interpret the absolute value of the estimated coefficients rather as lower bounds of the true relationship and focus on the direction of the relation.

Throughout all the specifications we exclude the last two quarters in our sample, as at that time the crisis had already intensified, asset-backed securities were considered "toxic" and securitization was for practical purposes not feasible. We report the estimation results using the counterfactual total regulatory capital to risk-weighted assets ratio in Table 3.1 and alternatively using the tier 1 capital to total assets ratio in Table 3.2. In all the spec-

[27] See Hausman et al. (1998).

Table 3.1: The extensive margin of securitization: using Capital/RWA Corrected

Dependent Variable:	Securitization Dummy						
Estimation:	Pooled Probit						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital/RWA Corrected	-6.20*	-5.60*	-5.60*	-7.21*	-5.63*	-5.73*	-6.57*
	(3.26)	*(3.18)*	*(3.13)*	*(3.87)*	*(3.10)*	*(3.11)*	*(3.68)*
Log of Total Assets	0.39***	0.41***	0.39***	0.40***	0.37***	0.39***	0.39***
	(0.043)	*(0.043)*	*(0.044)*	*(0.042)*	*(0.046)*	*(0.044)*	*(0.045)*
Credit Card Bank	1.82***	1.38***	1.73***	1.44***	1.80***	1.78***	1.32***
	(0.26)	*(0.27)*	*(0.31)*	*(0.43)*	*(0.27)*	*(0.27)*	*(0.39)*
Yield Loans and Leases		5.30**					2.65
		(2.68)					*(4.32)*
Financing Costs			2.52				2.36
			(11.1)				*(12.1)*
Credit Risk (Loss Allowances)				10.7			8.89
				(8.49)			*(10.4)*
Investment Banking					5.77*		5.81*
					(3.48)		*(3.51)*
Tax Rate						-0.010	-0.011*
						(0.0063)	*(0.0062)*
Fed Funds Rate							-0.16
							(0.13)
Baa Risk Premium							-1.48*
							(0.89)
Quarter dummies	yes	yes	yes	yes	yes	yes	yes
Observations	8445	7875	7941	8372	7941	7939	7873
Number of bank clusters	506	503	506	503	506	506	503
Wald statistic	224	223	240	270	212	214	298
Pseudo R-squared	0.36	0.35	0.35	0.37	0.36	0.36	0.37

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Constant and quarter dummies are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

ifications we use the first lags of the explanatory variables[28] to reduce the problems due to omitted variables or reverse causality, as lags are naturally correlated with the contemporaneous values and at the same time they are less likely to be correlated with the error term.[29] We control for possible changes in securitization activity over time for instance due to changes in investor demand by using time dummies. Only in the last specification in column (7) we control directly for the stance of monetary policy and the risk appetite of investors.[30] Furthermore, we include a dummy variable that equals 1 if the institution is a credit card specialty bank in addition to the variables described in the previous section, as banks specialized in credit card loans use credit risk transfer instruments more often than other commercial banks. We finally estimate the model using the standard capital ratios and compare the results to check to what extent endogeneity is a problem. These results are reported in Tables 3.12 and 3.13 in Appendix B.

Let us first have a look at Table 3.1. Reported are the coefficients[31] of a pooled probit estimation of the probability of securitizing on the corrected total capital to risk-weighted assets ratio, the logarithm of total assets, the debt financing costs, the yield on loans and leases, loan loss allowances, investment banking activities, average tax rate, and a credit card bank dummy.

Banks indeed seem to use securitization techniques to circumvent capital regulation. Throughout all the specifications the coefficient for the counterfactual capital to risk-weighted assets ratio is negative and significant at the 10% level. As expected, banks whose corrected capital ratio is low securitize with a higher probability. We interpret the result as evidence of capital arbitrage in securitization.

[28] Table 3.10 in Appendix B provides descriptive statistics for all explanatory variables. Furthermore, Table 3.11 in Appendix B shows their pairwise correlations.

[29] Non-linear estimation techniques, like maximum likelihood, are particularly sensitive to small endogeneity problems, which can cause a bias in the set of all the estimated coefficients.

[30] We continue to control for other time fixed effects by keeping a set of time dummies. Compared with the specifications without the two macro variables, we reduce the number of included time dummies by two.

[31] Note that in non-linear models the coefficients do not match the marginal effects, thus one cannot interpret their magnitude in the usual way but only their sign.

Using the standard capital to risk-weighted assets ratio, the results are quite different; see Table 3.12 in Appendix B. The coefficient is positive, though insignificant, suggesting, contrary to the capital arbitrage hypothesis, that capital-constrained banks tend to securitize with a lower probability. Again, as already pointed out, the standard capital ratio is endogenous and the estimated coefficient biased upwards. The endogeneity problem seems to be severe enough to alter the sign of the coefficient.

The size of the credit institution also matters for the securitization decision. The coefficient for the logarithm of total assets is positive and significant in all the specifications in Table 3.1, implying that larger institutions securitize assets with a higher probability. Our intuition for the result is that high fixed costs associated with securitization act as a barrier to market entry for smaller banks. The average securitization cost for these institutions would be higher, as they would generally want to securitize smaller pools of assets and the fixed costs cannot be spread across a large pool of loans. Furthermore, as expected banks specializing in credit card lending also securitize with a higher probability due to their special business model.[32]

To test whether profitability influences the probability of securitizing, we include the yield on loans and leases in columns (2) and (7). The coefficient reported in column (2) is significant and positive, which at first sight supports the idea of profitable banks more easily affording the high up-front costs of securitization. Once we also control for all the other determinants, though, the coefficient becomes insignificant; see column (7). The estimate in column (2) possibly suffers from an omitted variable bias. The origination of riskier credit is associated with higher yields. Therefore, if higher credit risk increases the probability of securitizing, the yield on loans and leases may capture some of its effect. Not controlling for credit risk induces an upward bias in the coefficient in specification (2). Once we control for it in column (7), the bias disappears and the coefficient on yield on loans and leases becomes insignificant.

We are not able to find evidence in support of banks engaging in securiti-

[32]Gorton and Souleles (2006) point out that credit card securitization is the second largest segment after mortgage backed securities issuance.

zation either as a means to share credit risk or as a way to fund loans at more favorable debt financing costs. Both coefficients have the expected positive sign,[33] but are insignificant. Thus, our empirical results do not confirm the hypothesis of securitization mainly used as a tool for transfering credit risk from the banking industry to sectors more capable or willing to bear them. Capital arbitrage rather seems to be the driving motive for the extensive margin.

The degree to which banks engage in investment banking activities influences as expected their decision to securitize positively. The coefficient for investment banking activities is positive and significant in both columns (5) and (7). Additionally to economies of scope, tax considerations seem to be important. Banks with higher tax rates benefit more from tax deductibility, therefore, we expect that higher tax rates correlate negatively with the probability of securitizing. The coefficient is indeed negative, but significant only in the last specification.

Even though the main focus of our empirical analysis lies in identifying supply-side factors in securitization, we include the federal funds rate and the Baa risk premium in the last specification (7). Both regressors capture variations in investor demand for asset-backed securitites. The respective coefficients have the expected negative sign. Loose monetary policy, captured by low levels of the fed funds rate, generally leads to higher investor demand for more risky but higher yielding investment opportunities, among others also in asset-backed securities. In turn, it should increase the probability of securitizing for all the institutions in the sample. Similarly, low levels of the Baa risk premium relate to a high appetite for risk of investors and are expected to lead to a higher probability of securitizing. Only the coefficient for the Baa risk premium is significant, though. The results are sensitive to changes in the set of included time dummies and should not be overemphasized.

Table 3.2 summarizes the results of the same analysis, using the corrected tier 1 to total assets ratio instead of the corrected ratio of capital to risk-

[33] Both when included individually in columns (3) and (4), respectively, and when controlling for all the possible determinants in column (7).

Table 3.2: The extensive margin of securitization: using Tier 1/Total Assets Corrected

Dependent Variable:	**Securitization Dummy**						
Estimation:	**Pooled Probit**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tier 1/Total Assets Corrected	-5.28**	-5.00*	-4.82*	-6.63**	-4.94*	-4.76*	-5.98*
	(2.60)	*(2.77)*	*(2.57)*	*(3.22)*	*(2.61)*	*(2.52)*	*(3.28)*
Log of Total Assets	0.38***	0.40***	0.38***	0.39***	0.36***	0.38***	0.38***
	(0.044)	*(0.044)*	*(0.045)*	*(0.045)*	*(0.047)*	*(0.045)*	*(0.047)*
Credit Card Bank	1.95***	1.49***	1.85***	1.65***	1.92***	1.90***	1.46***
	(0.29)	*(0.28)*	*(0.34)*	*(0.44)*	*(0.30)*	*(0.30)*	*(0.39)*
Yield Loans and Leases		5.52**					3.38
		(2.67)					*(4.18)*
Financing Costs			2.63				1.54
			(10.8)				*(12.0)*
Credit Risk (Loss Allowances)				9.85			7.54
				(8.52)			*(10.3)*
Investment Banking					5.18		5.18
					(3.30)		*(3.28)*
Tax Rate						-0.0089	-0.0095
						(0.0062)	*(0.0062)*
Fed Funds Rate							-0.14
							(0.12)
Baa Risk Premium							-1.36
							(0.87)
Quarter dummies	yes	yes	yes	yes	yes	yes	yes
Observations	8445	7875	7941	8372	7941	7939	7873
Number of bank clusters	506	503	506	503	506	506	503
Wald statistic	196	195	220	242	186	187	274
Pseudo R-squared	0.35	0.35	0.34	0.36	0.35	0.35	0.36

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Constant and quarter dummies are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

weighted assets. All the coefficients are very similar in magnitude to those reported in Table 3.1. Capital arbitrage considerations, economies of scale, and being a credit card bank significantly influence the probability of securitizing of banks in our sample. The previously significant effects of taxes and investment banking activities are no longer so.[34]

Worthwhile is again the comparison of estimation results with those using the standard tier 1 ratio instead of the corrected one. Table 3.13 in Appendix B reveals that the coefficient of the standard ratio is positive and significant at the 5% level throughout all the specifications. Recall that when using the standard capital to risk-weighted assets ratio the positive coefficient was not significant. We believe that the endogeneity problem for the standard tier 1 ratio is more severe, as securitization for regulatory capital purposes leads to a higher increase in the Tier 1/Total Assets ratio than in the Capital/RWA ratio. The reason is quite straightforward: whereas securitization leads to a similar reduction in the numerator of both ratios because the provided credit enhancements have to be deducted, the denominator of the tier 1 ratio decreases typically more strongly as the assets are not weighted and on average the risk weighting is lower than 1. Again, endogeneity is indeed a problem, and if not considered biases the results significantly.

3.6 The intensive margin of securitization

After having analyzed the participation decision of banks, we turn our attention to the question of why some banks use securitization on a larger scale and/or more often. We label it the *intensive* margin of securitization. Among the securitizing banks in our sample, the median bank securitizes in 4 out of 19 quarters, with around 44% of the banks being active only once or twice during the sample period. The securitized assets of the median bank amount to only around 3.7% of its on-balance-sheet assets, whereas banks at the 75th percentile of the distribution have around 23% securitized to retained assets. A natural question, thus, is which factors account for these

[34] The p-values rise to 12-13%.

observed differences *within* the group of securitizing banks.

In this section we use a more structural model of securitization activities. Instead of grouping the banks into securitizers and non-securitizers, based on the change in the amount outstanding of securitized assets, we try to model the evolution of the stock of those assets and "difference out" the new issuance of asset-backed securities.[35]

We start with the following identity, which shows the evolution of the amount outstanding of securitized assets:

$$S_{it} = S_{i,t-1} + newissuance_{it} - repayment_{it} - chargeoffs_{it} \tag{3.5}$$

where S_{it} denotes the amount outstanding of assets securitized by bank i in period t. The identity simply says that the stock of securitized assets increases with the issuance of new asset-backed securities and decreases with loan repayments as well as loan charge-offs. Since we observe the charge-offs on the securitized assets in each period we can rewrite the equation as:

$$S_{it} + chargeoffs_{it} = S_{it}^{gross} = S_{i,t-1} + newissuance_{it} - repayment_{it} \tag{3.6}$$

In the next step we model the unobserved "repayment" term as a function of observables. The amount of repayments depends positively on the outstanding amount of assets. Further determinants are macroeconomic factors like the interest rates or the business cycle, because for example a low unemployment rate raises the probability that loans will be payed back on time and low interest rates lead to prepayments and refinancing of loans at more favorable terms. Finally, we add time-invariant, bank-specific factors to account for unobserved characteristics that potentially influence the repayment series for each bank in our sample. We end up with the following

[35] Prior literature using stock data, e.g. Gorton and Souleles (2006) among others, pursues a different empirical modeling strategy. Researchers typically use models that ignore the dynamics of the outstanding securitized assets. However, given the observed dependence of the stock data over time, this is an unnatural assumption.

linear structure on $repayment_{it}$:

$$repayment_{it} = \alpha S_{i,t-1} + \omega_t + \psi_i + \xi_{it} \tag{3.7}$$

where ω_t captures all the relevant time-varying factors (e.g. interest rates, unemployment rate, GDP growth), ψ_i stands for time-invariant determinants, and ξ_{it} is a well-behaved random error term.

Plugging equation (3.7) into (3.6) delivers:

$$S_{it}^{gross} = (1-\alpha)S_{i,t-1} + newissuance_{it} - \omega_t - \psi_i - \xi_{it} \tag{3.8}$$

Next, we use the determinants of new issuance described in the previous section to complete the estimable equation. Assuming further that there are time-specific, but bank-invariant and time-constant, bank-specific factors that influence the decision to securitize new assets, we end up with our final specification:[36]

$$S_{it}^{gross} = (1-\alpha)S_{i,t-1} + \boldsymbol{x}_{it}\boldsymbol{\gamma} + \omega_t^* + \psi_i^* + \xi_{it}^* \tag{3.9}$$

The main advantage of this specification as opposed to the previous probit model is that here we can partially account for the heterogeneity between banks using bank fixed effects. Moreover, this dynamic model will allow us to test whether our main regressors are exogenous and hence whether our predictions are valid.

Estimating the above relationship via simple OLS and treating $\psi_i^* + \xi_{it}^*$ as the composite error term is problematic in several ways.[37] First, ψ_i^* and $S_{i,t-1}$ are mathematically related and this will lead to biased estimates. A solution is to eliminate the bank fixed effects by substracting the time mean

[36] ω_t^* , ψ_i^*, and ξ_{it}^* are the composite terms. $\boldsymbol{x}_{it}$ is the vector of determinants of securitization as described in the previous section.

[37] Equation (3.9) is close to the one with a lagged dependent variable because S_{it}^{gross} and S_{it} are highly correlated. The sample correlation coefficient is $corr(S_{it}^{gross}, S_{it}) = 0.999$. Charge-offs are small relative to the outstanding amounts; hence the variation in the dependent variable is driven by the variation in S_{it}. Including charge-offs on the right-hand side (as the regressor) instead of on the left-hand side, which leads to a standard model with a lagged dependent variable, delivers the same results.

for each bank.[38] However, a problem still remains, because the transformed lagged dependent variable (LDV) is correlated with the transformed error term. Nickell (1981) showed that this introduces a bias into the estimates, that disappears only for $T \to \infty$.[39] We use a technique, first proposed by Anderson and Hsiao (1982) to solve the problem. In order to eliminate the fixed effects first differences are taken from both sides of equation (3.9):

$$S_{it}^{gross} - S_{i,t-1}^{gross} = (1-\alpha)(S_{i,t-1} - S_{i,t-2}) + (\boldsymbol{x}_{it} - \boldsymbol{x}_{i,t-1})\boldsymbol{\gamma} + \\ +(\omega_t^* - \omega_{t-1}^*) + (\xi_{it}^* - \xi_{i,t-1}^*) \qquad (3.10)$$

Again there is a correlation between the $S_{i,t-1} - S_{i,t-2}$ term and the transformed error term $\xi_{it}^* - \xi_{i,t-1}^*$. To solve the endogeneity problem, one uses an instrumental variable estimator. Anderson and Hsiao (1982) propose the lagged level $S_{i,t-2}$ or the lagged difference $S_{i,t-2} - S_{i,t-3}$ as natural instruments, because they are correlated with $S_{i,t-1} - S_{i,t-2}$, but not with the error term.[40] The instruments are valid if $\xi_{it}^* - \xi_{i,t-1}^*$ is not first-order autocorrelated or equivalently the level ξ_{it}^* doesn't follow a second-order autoregressive process.[41]

Holtz-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) propose a generalized method of moments (GMM) estimation of equation (3.10), which is more efficient than that of Anderson and Hsiao (1982). As we go further in time more lagged values can serve as instruments, and more moment conditions can be used to improve efficiency. The GMM framework allows us in addition to test for the exogeneity of the instrument set.[42]

[38] The within-group transformation.

[39] Further, Judson and Owen (1999) find that this bias is important (around 20%) even for $T = 30$.

[40] Instrumenting in this manner does not work with the within-group transformation.

[41] The first-difference representation introduces serial correlation of the transformed errors (assuming no autocorrelation in levels), but this can be easily treated by using GLS or by using robust variance-covariance estimators.

[42] Arellano and Bover (1995) and Blundell and Bond (1998) point out that "difference" GMM may perform poorly when the time series are very persistent. In this case lagged levels are poor instruments of first differences, which produce the "weak instrument problem". They propose the so-called "system" GMM estimator, where an equation in levels

The following moment conditions can be used in the estimation:

$$E[S_{i,t-l}(\xi^*_{it} - \xi^*_{i,t-1})] = 0 \ \text{ for each } t \geq 3 \text{ and } l \geq 2 \tag{3.11}$$

We decide to exploit the "collapsed" version following Roodman (2009b) to reduce the problem of "too many instruments".[43] Thus, we use the following moment conditions:

$$E[S_{i,t-l}(\xi^*_{it} - \xi^*_{i,t-1})] = 0 \ \text{ for each } l \geq 2 \tag{3.12}$$

The additional usual moment conditions are of the form:

$$E[(\boldsymbol{x}_{it} - \boldsymbol{x}_{i,t-1})'(\xi^*_{it} - \xi^*_{i,t-1})] = \mathbf{0} \ \text{ for } t \geq 2 \tag{3.13}$$

where the row vector $\boldsymbol{x}$ contains all the strictly exogenous explanatory variables. If some of the covariates are potentially predetermined or endogenous we use suitable lagged levels to instrument the difference $x_{it} - x_{i,t-1}$.[44]

We address several issues in our estimation. First, we use the amount outstanding of securitized assets as a share of the total managed assets of the bank instead of the level of S_{it}.[45] The total managed assets are defined as the sum of the total on-balance-sheet assets and the total securitized assets. This helps us to avoid problems due to non-stationarity of the series.[46] Sec-

is added to the system of differenced equations. Here the intuition is to instrument levels with differences. However, a crucial and non-trivial assumption requires that the covariance $E[S_{it}\psi^*_i]$ is constant over time (stationary) so that $E[(S_{it} - S_{i,t-1})\psi^*_i] = 0$. The condition is required for **all** the instruments. We believe that the initial stationarity of the time series for the securitized assets is not satisfied because there is a clear upward trend in the stock of asset-backed securities between 2003 and 2007. Therefore, system GMM is not appropriate.

[43] This problem arises because as we go further in time, there are more lags of the dependent variable, which can potentially serve as instruments.

[44] We start by treating these variables as strictly exogenous and perform Difference-in-Hansen tests of exogeneity of instrument subsets. If these reject the null hypothesis of exogeneity we use appropriate lagged levels instead.

[45] The average bank has about 15% and the median bank about 3.5% securitized in all managed assets.

[46] Furthermore, the approach has the following advantage over using on-balance-sheet assets only in the denominator. If a bank securitizes assets, without expanding its on-balance-sheet lending, we will observe higher S_{it} as well as lower retained assets. The share of securitized to retained assets will increase sharply, since both the nominator

ond, we perform the "one-step" GMM estimation and produce test statistics by applying the cluster-robust estimator of the variance-covariance matrix of residuals, which allows for arbitrary correlation within banks and heteroskedasticity across banks.[47] Third, we test for AR(1) and AR(2) in the first-differenced errors using the Arellano-Bond test for autocorrelation to check whether our instruments are valid. In theory there is a negative first-order autocorrelation in first differences, but there should be no second or higher order autocorrelation. Fourth, we conduct a Hansen (1982) test of overidentifying restrictions to test for the exogeneity of the instrument set as a whole. In addition, to test whether our "corrected" capital ratio measure is exogenous, we perform a Difference-in-Hansen test. We test further whether all the other strictly exogenous explanatory variables are indeed orthogonal to the residuals, but we do not present them in the tables for sake of clarity. Finally, we address the problem of "too many instruments". Since we have a relatively small sample "overfitting" endogenous variables by using too many moment conditions may be a problem.[48] Therefore, we decide to restrict the lag length to using only up to the first five available lags. In addition we "collapse" them into a smaller instrument set. As a consequence, our system of equations has two or three overidentifying restrictions.

Table 3.3 shows the estimation results using the Capital/RWA Corrected ratio, whereas Table 3.4 uses the Tier1/ Total Assets Corrected ratio.[49] The results are qualitatively comparable; therefore, we focus on the results reported in Table 3.3. We use two samples in our analysis. The narrow sample in columns (3) and (4) consists of all the securitizers from the sample used

increases and the denominator decreases.

[47]In theory "two-step" GMM estimation produces a heteroskedasticity- and autocorrelation-robust variance-covariance matrix and is more efficient than the one-step approach. However, as Arellano and Bond (1991) and Roodman (2009a) point out, standard errors can be severely downward biased in small samples. In this case standard errors can then be adjusted using the finite-sample correction of Windmeijer (2005), but since this is only an approximation we decide to stick to our one-step results.

[48]Roodman (2009b) emphasizes that the available instruments may rise quadratically with the number of time periods. For our sample with 18 quarters the maximum potentially available moment conditions amount to $(18-2)(18-1)/2 = 136$.

[49]We use the *xtabond2* command in Stata provided by Roodman (2009a) to obtain our results.

Table 3.3: Dynamic difference GMM estimation results using Capital/RWA Corrected

Dependent Variable:	Securitized to Total Managed Assets (gross)			
Sample:	broad		narrow	
Instruments:	L2-L4.S	L2-L5.S	L2-L4.S	L2-L5.S
	(1)	(2)	(3)	(4)
L1.(Securitized to Total Managed Assets)	0.59*	0.55**	0.81**	0.80**
	(0.31)	*(0.28)*	*(0.41)*	*(0.37)*
Capital/RWA Corrected	-1.13**	-1.15**	-1.20*	-1.21*
	(0.54)	*(0.54)*	*(0.61)*	*(0.62)*
Log of Total Assets	-0.15***	-0.15***	-0.15***	-0.15***
	(0.049)	*(0.048)*	*(0.048)*	*(0.048)*
Yield Loans and Leases	0.13	0.13	0.12	0.12
	(0.097)	*(0.095)*	*(0.11)*	*(0.11)*
Financing Costs	1.70***	1.69***	1.93***	1.93***
	(0.64)	*(0.63)*	*(0.72)*	*(0.70)*
Credit Risk (Loss Allowances)	0.037	0.071	0.096	0.11
	(0.59)	*(0.56)*	*(0.61)*	*(0.58)*
Investment Banking	-0.034	-0.034	-0.047	-0.047
	(0.066)	*(0.065)*	*(0.073)*	*(0.072)*
Tax Rate	-0.000063	-0.000063	-0.000070	-0.000071
	(0.00012)	*(0.00012)*	*(0.00015)*	*(0.00015)*
Fed Funds Rate	-0.047	-0.042	-0.20	-0.19
	(0.37)	*(0.36)*	*(0.53)*	*(0.52)*
Baa Risk Premium	-0.039	-0.034	-0.19	-0.19
	(0.39)	*(0.38)*	*(0.55)*	*(0.55)*
Quarter dummies	yes	yes	yes	yes
Observations	1141	1141	955	955
Number of bank clusters	103	103	77	77
Number of instruments	26	27	26	27
F statistic	2.62	2.67	2.33	2.37
F-Test (p-value)	0.0004	0.0003	0.003	0.002
AR(1) Test	-1.68	-1.70	-1.83	-1.95
AR(1) Test (p-value)	0.09	0.09	0.07	0.05
AR(2) Test	-0.79	-0.75	-1.16	-1.15
AR(2) Test (p-value)	0.43	0.45	0.25	0.25
Hansen-J statistic	0.72	1.20	0.056	0.12
Hansen-J (degrees of freedom)	2	3	2	3
Hansen-J (p-value)	0.70	0.75	0.97	0.99
Diff-in-Hansen statistic for Capital/RWA Corrected	0.36	0.03	0.03	0.01
Diff-in-Hansen (p-value)	0.55	0.87	0.86	0.94

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Estimates are one-step difference GMM. The table shows the Arellano-Bond test for first- and second-order autocorrelation of the first-differenced residuals. The null hypothesis is no autocorrelation. A heteroskedasticity-robust test of overidentifying restrictions (Hansen J-test) is performed. The null hypothesis is that the instrument set as a group is exogenous. A Difference-in-Hansen test for exogeneity of the instrument subset (here of the capital ratio) is performed. Under the null the instrument excluded is exogenous. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3.4: Dynamic difference GMM estimation results using Tier1/Total Assets Corrected

Dependent Variable:	Securitized to Total Managed Assets (gross)			
Sample:	broad		narrow	
Instruments:	L2-L4.S	L2-L5.S	L2-L4.S	L2-L5.S
	(1)	(2)	(3)	(4)
L1.(Securitized to Total Managed Assets)	0.70**	0.64**	0.92**	0.87**
	(0.33)	*(0.30)*	*(0.44)*	*(0.40)*
Tier1/Total Assets Corrected	-1.44*	-1.48*	-1.63*	-1.65*
	(0.79)	*(0.80)*	*(0.84)*	*(0.84)*
Log of Total Assets	-0.16***	-0.16***	-0.16***	-0.16***
	(0.054)	*(0.053)*	*(0.052)*	*(0.052)*
Yield Loans and Leases	0.12	0.11	0.099	0.097
	(0.11)	*(0.10)*	*(0.11)*	*(0.11)*
Financing Costs	1.96***	1.95***	2.27***	2.26***
	(0.74)	*(0.73)*	*(0.82)*	*(0.80)*
Credit Risk (Loss Allowances)	0.13	0.19	0.30	0.34
	(0.57)	*(0.54)*	*(0.58)*	*(0.54)*
Investment Banking	-0.028	-0.029	-0.041	-0.041
	(0.065)	*(0.064)*	*(0.072)*	*(0.070)*
Tax Rate	-0.000064	-0.000064	-0.000049	-0.000049
	(0.00014)	*(0.00014)*	*(0.00016)*	*(0.00016)*
Fed Funds Rate	-0.22	-0.22	-0.55	-0.55
	(0.39)	*(0.38)*	*(0.56)*	*(0.55)*
Baa Risk Premium	-0.22	-0.22	-0.57	-0.57
	(0.41)	*(0.40)*	*(0.59)*	*(0.57)*
Quarter dummies	yes	yes	yes	yes
Observations	1141	1141	955	955
Number of bank clusters	103	103	77	77
Number of instruments	26	27	26	27
F statistic	2.26	2.34	2.08	2.15
F-Test (p-value)	0.003	0.002	0.008	0.006
AR(1) Test	-1.96	-1.95	-2.00	-2.06
AR(1) Test (p-value)	0.050	0.051	0.046	0.040
AR(2) Test	-1.36	-1.39	-1.39	-1.44
AR(2) Test (p-value)	0.17	0.16	0.16	0.15
Hansen-J statistic	0.73	1.80	0.48	0.81
Hansen-J (degrees of freedom)	2	3	2	3
Hansen-J (p-value)	0.69	0.61	0.79	0.85
Diff-in-Hansen statistic for Tier1/Total Assets Corrected	0.02	0.13	0.06	0.07
Diff-in-Hansen (p-value)	0.89	0.72	0.81	0.79

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Estimates are one-step difference GMM. The table shows the Arellano-Bond test for first- and second-order autocorrelation of the first-differenced residuals. The null hypothesis is no autocorrelation. A heteroskedasticity-robust test of overidentifying restrictions (Hansen J-test) is performed. The null hypothesis is that the instrument set as a group is exogenous. A Difference-in-Hansen test for exogeneity of the instrument subset (here of the capital ratio) is performed. Under the null the instrument excluded is exogenous. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

in our binary choice model. In addition, we collected data on all the securitizers with assets between 300 million and 1 billion dollars in the second quarter of 2008. There are 30 banks reporting securitization activities in this sub-group. By adding these banks to our narrow sample we obtain the broad sample used in columns (1) and (2). Beyond the advantage of using more observations this allows us to see whether the inclusion of other banks alters our results. We further present results using two different instrument sets: the first includes the second, third, and fourth lags of S_{it} in column (1) whereas the second includes in addition the fifth lag in column (2).

Throughout all the specifications the Arellano-Bond test suggests the existence of negative first-order serial correlation in the first-differenced residuals at the 10% significance level, that is expected by construction. The test cannot reject the null hypothesis of the absence of AR(2) in the first-differenced residuals, indicating that the lagged levels of the dependent variable are valid instruments. Furthermore, the p-value of the Hansen J-test ranges between 0.70 and 0.99. The null hypothesis of exogeneity of the instrument set as a whole cannot be rejected. Therefore, endogeneity is not driving our results.

A brief look at the table reveals that the results are in general not sensitive to different samples or to the use of different instrument sets. Therefore, we interpret only the results in column (1). Banks with a lower capital ratio securitize more. The estimated coefficient is significantly different from zero at the 5% level. To quantify the effect we compare a bank at the 75th percentile of the distribution of the capital ratio with a bank at the 25th percentile. The latter has an approximately 2 percentage points lower ratio of capital to risk-weighted assets. The coefficient of -1.13 implies that this bank will have 2.26 percentage points higher securitized in total managed assets. However, since we have a dynamic model, the coefficient represents only the contemporaneous effect. The long-run impact is given by $\gamma/(1-(1-\alpha))$.[50] Given the estimate for $(1-\alpha)$ of 0.59, the long-run effect amounts to $2.26/(1-0.59) = 5.51$ percentage points. The result suggests that the

[50]This is approximately true, because S_{it}^{gross} and S_{it} have almost equal values.

capital arbitrage is important for *both* the extensive *and* the intensive margin of securitization. The performed Difference-in-Hansen test cannot reject the null hypothesis of the exogeneity of Capital/RWA Corrected.[51]

A second important finding is that the financing costs seem to be a further important determinant of the scale of securitization activity. This result supports the efficient contracting view of securitization and is in line with other empirical papers. Looking at column (1) of the table, the coefficient on this variable is positive and statistically significant at the 1% level. An originating bank in the 75th percentile of the distribution faces 1.5 percentage points higher debt financing costs compared with a bank at the 25th percentile. This bank will therefore have around a $1.7 * 1.5 = 2.55$ percentage points higher share of securitized in the total managed assets. In the long run the impact is even higher - 6.22 percentage points.[52]

Another interesting result is the negative, significant at the 1% level coefficient on the total assets variable. Bigger banks seem to have a lower share of securitized in the total managed assets.

Finally, the variables tax rate and investment banking activities do not have a significant impact on the decision on the scale of securitization. These factors seem to determine only the participation decision. If expertise in investment banking influence only the amount of up-front fixed costs of entering the market, like setting up a special purpose vehicle and placing the securities on the market, then this variable will influence indeed only the participation of banks. Bank profitability and credit risk exposure have the expected positive sign, but are again not significant.

Finally, we want to emphasize the appropriateness of our estimation procedure and the importance of bank fixed effects. Therefore, we estimate the model in equation (3.9) using the fixed-effects (FE) as well as the random-effects (RE) estimator. Table 3.14 in Appendix B shows the estimation results.

First, to indicate the importance of fixed effects, we compare the estimates in column (1) for the random-effects case with column (2) for the fixed-effects

[51]The test statistic is $\chi^2(1)$ distributed. The computed p-value is 0.55.

[52]$6.22 = 2.55/(1 - 0.59)$.

case, in both of which use the capital/RWA corrected as the measure for the capital adequacy of a bank.[53] There are significant differences. Comparing the coefficient on the lagged dependent variable, we see in the RE case that it is biased upwards. The result is reasonable, because we expect a positive correlation between the lagged dependent variable and the unobserved fixed effect ψ_i^*. Further, we see an upward bias towards zero for the coefficient on the capital ratio, which is plausible for a positive correlation between it and the unobserved fixed effect ψ_i^*. The table shows in addition the estimated variance due to the fixed effects relative to the overall variance. The *Rho* statistic for the fixed-effects within-estimation is near 1, which confirms the importance of including bank fixed effects.

Second, we can compare the Arellano-Bond estimates in column (3) of Table 3.3 with the fixed-effects estimates in column (2) of Table 3.14. Both use the same narrow sample. Although both estimators account for fixed effects, the latter suffers from the "Nickell" bias. The coefficient on the capital ratio is clearly biased towards 0. The bias is significant and amounts to around 33%[54] of the coefficient. Furthermore, the coefficient on the financing costs variable is around 17%[55] biased downward. In line with the econometric literature, this suggests that the within-group estimator is not suitable for our small T sample.

Overall when considering the intensive margin, we find support for both the capital arbitrage view and the efficient contracting view of securitization.

3.7 The incentive effects of securitization

After having provided evidence that capital arbitrage drives asset securitization by banks, we turn to the question of whether and how securitization affects the quality of originated loans. First, we compare the ex-post perfor-

[53] A clearer way to test the appropriateness of both estimators would be to perform a Hausman specification test. A necessary assumption for the test is that the fixed-effects estimator is consistent. However, in the presence of a lagged dependent variable this assumption is not fulfilled.

[54] $0.33 = (1.20 - 0.80)/1.20$.

[55] $0.17 = (1.93 - 1.61)/1.93$

mance of securitized and retained loans and interpret the observed disparity as evidence of incentive problems. Second, we identify which contractual features and bank characteristics can remedy such problems.

In this section we focus *only* on the sub-sample of securitizing banks. We argue that pooling securitizers with non-securitizers will be misleading and probably overstate the true impact of securitization on the quality of originated loans. The intuition is straightforward. Suppose for a moment that securitization does not lead to bad incentives so that loans originated by the same bank exhibit the same delinquency rates, irrespective of whether they are securitized or not. However, securitizing banks may be systematically involved in a riskier lending.[56] There will be a different performance of securitized loan pools vs. on-balance sheet loan pools simply due to a *selection* of securitizers into such riskier business. However, the disparity would not relate to bad incentives. By focusing on the sub-sample of securitizing banks we rule out such a selection. In a way our empirical strategy boils down to comparing the ex-post observed performance of loans originated by the *same* institution, of the *same* type,[57] observed at the *same* time, which are securitized to those retained on the balance sheet.

Figure 3.8 summarizes the delinquency rates of home equity loans for the time period between the fourth quarter of 2003 and the second quarter of 2008. The blue bars denote the average delinquencies of retained loans and the red bar the delinquencies of loans originated and securitized by the same group of banks. The two upper panels summarize data on loans more than 30 days past due. Throughout the time period securitized home equity loans had a higher fraction of borrowers failing to meet the due payments than home equity loans originated by the same group of banks and retained by the originator. The lower-left panel features data on the charge-offs. Up until the last quarter of 2007 the development resembles the upper panels. In the last 3 quarters during which the current crisis emerged and intensified, however, the losses on retained loans were substantially higher. Anecdotal evidence suggests that securitization in that particular period was practically

[56] Figure 3.4 indicates this.

[57] For example, credit card debt or residential mortgages.

Notes: Quarters denoted on the horizontal axis. 2 is the fourth quarter of 2003; 20 is the second quarter of 2008.

Figure 3.8: Delinquencies on securitized and retained home equity lines

impossible and banks were forced to retain loans they planned to securitize. Additionally, banks had to put recently securitized assets, that had quickly become sour, back on their balance sheets in an act of implicit support for reputational purposes. Thus, some of the defaults denoted in the graph as defaults on retained loans could actually reflect losses on either loans that were originally securitized but had to be put back on the balance sheet or loans that were planned to be securitized.

The lower-right panel sums up all the non-performing loans - between 30 and 89 days past due, more than 90 days past due, and those charged off - as the total delinquency rate on home equity loans. This is how we measure "quality". The measure has some caveats. First of all it is an ex-post measure so the poor performance of securitized assets might be the result of "bad luck". A more serious caveat is that the measure does not capture the true profitability. Even though securitized loans are riskier and default more often, the interest rates charged for such loans may be sufficiently high to make them a profitable investment. We do not have any data on interest income for securitized loans, thus, we cannot take it into account in our analysis.

We observe the same pattern for other types of loans too. Table 3.5 summarizes the total delinquencies for home equity loans, credit card loans, commercial loans, and other loans.[58] For residential mortgages we do not have data on past dues, so instead of total delinquencies we report booked losses only. The t-test reported in Table 3.5 reveals that total delinquencies on securitized loans are significantly higher for every loan category apart from residential mortgages. We interpret this as evidence that moral hazard and/or adverse selection are a problem in securitization. Obviously banks tend to originate and securitize substantially riskier loans compared with the ones they retain and for which they are liable with their own equity.

Complementary to Table 3.5 we perform a regression-based mean com-

[58]We provide additional details on the quality characteristics of retained and securitized loans in Table 3.15 in Appendix B.

Table 3.5: Mean comparison of total delinquencies on securitized vs. retained loans

	Mean of Total Delinquencies		Diff(mean) > 0 p-value
type of loan	securitized loans	retained loans	
Residential Mortgages*	0.18	0.17	0.370
Home Equity Loans	3.41	1.29	< 0.001
Credit Card Debt	7.87	6.23	0.046
Commercial Loans	3.05	2.34	0.006
Other Loans	3.02	0.85	< 0.001

Notes: * The total delinquencies of residential mortgages contain booked losses only. The last column reports the p-value of a paired t-test with the null hypothesis that the mean for the securitized loans is equal to the mean for the retained loans vs. the alternative that the mean for the securitized loans is higher than the mean for the retained loans.

parison:

$$delinq_{jit} = \mu_0 + c_i + c_t + \mu_1 * dummy_{ji} + \mu_2 * controls_{jit} + \omega_{jit} \quad (3.14)$$

where the subscript j denotes the securitized vs. the retained pool of loans for each bank i at time t.

We pool the overall delinquency rates for retained loans and for securitized loans for each securitizing bank i and want to know whether the securitized loans ($dummy_{ji} = 1$) have higher overall delinquencies than the retained ones ($dummy_{ji} = 0$), controlling for bank fixed effects, time fixed effects, and the composition of both pools.[59] Compared with the previous by-type-of-loan comparison, the regression-based analysis using the overall delinquency rates

[59]Controlling for the composition of the portfolios here is crucial as certain types of loan exhibit higher delinquencies. Compare for instance the delinquency rates on home equity loans with those on credit card debt in Table 3.5. Differences in the average overall delinquency rate for securitized vs. retained assets in this specification, thus, may arise ceteris paribus if institutions for example securitize all of their credit card loans and retain all of their originated mortgages. To rule out biases due to systematical differences in the composition of the securitized and retained loan pools we explicitly control for their structure.

Table 3.6: Regression-based comparison of total delinquencies on securitized vs. retained loans

Dependent Variable:	Total Delinquencies
Dummy_{ji}	1.47**
	(0.35)
Composition of securitized portfolio	yes
Composition of retained portfolio	yes
Quarter dummies	yes
Bank fixed effects	yes
Observations	2026
Number of bank clusters	100
R-squared	0.2

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. The table shows fixed-effects within estimates. Controls for the composition of securitized and retained portfolios, quarter dummies, and a constant are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

allows us to exploit a larger fraction of the data.[60]

Equation 3.14 is estimated using the within-bank-group transformation. Inference is based on cluster-robust correction of the standard errors. We again exclude observations after the fourth quarter of 2007.

Table 3.6 shows the results. The estimated coefficient μ_1 is positive and significant at the 5% level, indicating that indeed securitized loans are more risky than retained loans. On average the overall delinquency rate of securitized assets in our sample is 1.47 percentage points higher. Given that the overall delinquency rate on retained loans is 1.29%, this is a large number. Further, the coefficients on the composition of both portfolios are jointly significant (F-test not reported), which supports our approach.

Once we have stated that indeed securitized loans exhibit much higher delinquency rates, a natural question to ask is: why? In a next step we identify and test whether the poor performance of securitized loans arises due to bad incentives for screening and monitoring.

The quality of securitized assets should depend on the segment of credit

[60]The reason is that even though banks report the overall delinquency rate for retained and securitized loans some of them do not provide disaggregated delinquency rates by type of loan.

markets in which the bank operates, the screening and monitoring effort exerted by bank staff, and unobserved bank characteristics, for instance how accurate the screening technology is, the managerial culture, etc.

We expect that the total delinquencies of securitized loans are higher for banks operating in riskier segments of the credit market, proxied by the total delinquencies of retained loans. This measure also captures the efficiency of the scoring technology available to individual banks for the assessment of borrower creditworthiness. Intuitively, banks that use a less precise scoring program and specialize in riskier lending will exhibit higher delinquencies on both their retained and securitized assets. Any systematical difference in the delinquencies of securitized and retained loans of the same type granted by the same bank is related to the *willingness* of bank insiders to use the available technology to screen and monitor borrowers and to possible changes in the bank's tolerance to risk for loans to be securitized as opposed to old-fashioned retained loans. Once we have controlled for the screening technology and the segment of credit markets, we can attribute any variation in the ex-post performance of securitized loans to incentives.

Theory suggests that screening and monitoring incentives could be undermined for securitized loans because the originator sells the assets to a third party and transfers most of the risk associated with them to the buyer. The bank is liable with its own equity for any future defaults only up to the stake it retains in the securitization transaction. This may induce banks to originate and securitize riskier loans and monitor borrowers less stringently once a loan is granted. The higher the fraction of the risk in a securitization transaction the originating bank retains, the less severe such moral hazard and adverse selection problems are, according to theory. We have data on credit enhancements and pro-rata stakes in securitizations retained by the originating banks and use them to test these predictions.

In addition to such contractually specified and disclosed retained risk, banks may also provide "implicit recourse", i.e. the bank implicitly promises to support its securitizations beyond its contractual obligations and thus bears additional risks. Banks may do this out of reputational concerns.[61] Such implicit, non-observable, and non-verifiable to outsiders guarantees must be self-enforcing in order to be effective. In this sense the amount of bank equity capital relative to assets influences incentives in two ways. First, provided that banks care about their reputation and promise implicitly to support securitizations, they are liable with their available equity only. The more capital relative to its assets a bank has, the better are its incentives to screen and monitor implicitly guaranteed securitized loans. Second, implicit recourse is only self-enforcing for banks with a large capital base relative to their assets. To put it in a nutshell, if a bank is on the brink of bankruptcy it would not care much about its future reputation, as the probability that it has a future is small anyway. Therefore, capital adequacy ensures self-enforceability.

For our regression analysis we use the overall delinquency rate of securitized assets ($delinq_{it}^{sec}$) as a measure of the quality of these assets. As a proxy for the quality of retained assets we use the overall delinquencies on retained loans ($delinq_{it}^{ret}$). To make sure differences in the average delinquencies do not arise because for example riskier types of loans constitute a higher fraction of the securitized portfolio, we control for the composition of the retained and securitized loan pools.[62]

As measures of the retained stake in its securitized assets ($retexp_{it}$) we use the size of the credit enhancements provided by the originating bank as well as the retained pro-rata ownership, both as a percentage of the securitized pool. We expect that both a bigger first-loss piece and a higher retained pro-rata share of ownership help overcome incentive problems and thus lead

[61] See Basel Committee on Banking Supervision (2006), p. 235.

[62] Ultimately we are interested in the differences in delinquencies for loans of the same type. Any comparison of the average delinquencies for all types of loans that does not take into account that certain types of loans exhibit higher delinquencies, e.g. credit card loans versus mortgages, could distort the results if banks for example securitize mortgages more easily than credit card debt and thus the composition of its balance sheet is different from the composition of its securitized assets. As not all the banks in our sample report delinquencies for retained and securitized loans by type of loans, we have to use the average delinquency rate of loans originated by a bank observed during a quarter and control for possible differences in the composition of retained and securitized loan pools.

to a better quality of securitized loans. We further expect that the marginal effect of credit enhancements is stronger. The intuition is straightforward: whereas an increase in the first-loss piece of 1 percentage point is associated with an increase in the retained fraction of the overall risk of more than 1%,[63] increasing the retained pro-rata ownership by the same magnitude increases the risk by exactly 1%. The higher the retained portion of risk is, according to theory, the more risk prevention is undertaken.

To test whether reputational concerns play a role we use four different measures of the capital adequacy of banks ($capratio_{it}$): a simple tier 1 leverage ratio, a ratio of risk-based capital to risk-weighted assets, and the corrected version of the two ratios used previously. In the current setting the corrected capital ratios measure the consolidated capital base that is there to back the risk inherent in both the retained and securitized assets of bank i. We expect that the better capitalized a bank is, the better the quality of its securitized assets, all other things held equal.

To control for unobservable bank-specific factors we use bank fixed effects. For example, a different maturity structure of the securitized portfolio relative to the retained portfolio can account for differences in the delinquencies. If these are correlated with our main explanatory variables, they would lead to inconsistent estimates.[64] We also include quarter dummies to capture aggregate time-specific effects. Finally, we control for bank size. The control for size is important, as size and leverage are correlated and thus omitting size may induce a bias into our estimates.

Our empirical model is given by the following linear relationship:

$$\begin{aligned} delinq_{it}^{sec} = \beta_0 + c_i + c_t + \beta_1 * delinq_{it}^{ret} + \beta_2 * capratio_{it} + \\ + \beta_3 * retexp_{it} + \beta_4 * controls_{it} + u_{it} \end{aligned} \tag{3.15}$$

We first perform a fixed-effects estimation of equation 3.15 and report the

[63]The first losses on the securitized portfolio are born solely by the holder of the first loss piece.

[64]The only assumption we need is that these factors are constant over our sample period.

results from our baseline model in Table 3.7.[65] The data sample covers 100 banks and 1013 bank-year observations. Throughout all the specifications we control for the composition of the retained and securitized portfolios as well as time- and bank-specific effects. Clustered standard errors that account for conditional heteroskedasticity between bank clusters and serial correlation of the residuals u_{it} within bank clusters are reported in parentheses.

Column (1) in the table reports the results of a regression of the total delinquencies on securitized assets on the delinquencies of retained assets. Not surprisingly, the estimated coefficient $\hat{\beta}_1$ is positive and significant at the 1% level. The point estimate of 1.58 indicates that indeed the delinquencies of securitized assets depend closely on those on the retained portfolio.

Next, we include the size of the first-loss piece in column (2). Contrary to what we expected, the coefficient is positive and significant at the 5% level. This implies that the higher the fraction of risk is retained, the worse the securitized assets perform. Subsequently we include the retained pro-rata ownership instead of the first-loss piece and report the results in column (3). The coefficient has the expected negative sign but is insignificant at the 10% level. In column (4) we also use both measures for retained risk by the originator simultaneously. The sign and significance of the coefficients do not change. We suspect that there may be a problem of reverse causality with regard to the variable first-loss piece. Banks that securitize assets with a less good quality must provide higher credit enhancements so that nevertheless asset-backed securities structured out of such collateral are granted a good rating and can be placed on the market. As the amount of retained pro-rata ownership does not provide any protection to investors against defaults and, thus, should not influence the rating of asset-backed securities, there is no reverse causality in this case. As a result we obtain the expected negative sign but the estimated coefficient is not statistically significant. In the further regressions we stick to using the first-loss piece as a control for the retained stake.

In columns (5) to (8) we subsequently use the four bank capital measures

[65] Table 3.9 in Appendix B provides pairwise correlations of the explanatory variables.

Table 3.7: Total delinquencies of securitized loans: FE estimates

Dependent Variable:	**Total Delinquencies of Securitized Loans**							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Delinquencies of Retained Loans	1.58***	1.57***	1.59***	1.58***	1.42***	1.43***	1.46***	1.45***
	(0.43)	*(0.42)*	*(0.43)*	*(0.42)*	*(0.31)*	*(0.31)*	*(0.35)*	*(0.34)*
First Loss Piece		2.89**		3.06**	3.02***	3.25***	2.93**	3.15***
		(1.31)		*(1.23)*	*(1.13)*	*(1.21)*	*(1.17)*	*(1.19)*
Retained Securitization Ownership			-0.48	-0.87				
			(0.56)	*(0.74)*				
Capital/RWA					-30.3***			
					(9.90)			
Capital/RWA Corrected						-33.2**		
						(13.4)		
Tier1/Total Assets							-31.5***	
							(9.61)	
Tier1/Total Assets Corrected								-42.3**
								(16.8)
Log of Total Assets					-1.16	-0.82	-1.40*	-1.22
					(0.83)	*(0.77)*	*(0.84)*	*(0.87)*
Composition of securitized portfolio	yes	yes	yes	yes	yes	yes	yes	yes
Composition of retained portfolio	yes	yes	yes	yes	yes	yes	yes	yes
Quarter dummies	yes	yes	yes	yes	yes	yes	yes	yes
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	1013	1013	1013	1013	1013	1013	1013	1013
Number of bank clusters	100	100	100	100	100	100	100	100
R-squared	0.538	0.546	0.538	0.547	0.569	0.568	0.561	0.563

Notes: Robust standard errors adjusted for clustering on bank-level in parentheses. The table shows fixed-effects within estimates. Controls for the composition of the securitized and the retained portfolios, quarter dummies and a constant are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

and control additionally for the size of banks. In all four cases the reported coefficients have the expected sign and are significant at the 5% level, suggesting that reputational concerns are indeed present. The more capital the originating banks have, the lower are the delinquencies of assets securitized by them. The effect of capital is quantitatively meaningful: increasing the ratio of capital to risk-weighted assets by 1 percentage point reduces ceteris paribus the delinquencies on securitized assets by approximately 0.3 percentage points. This makes up one-fifth of the observed discrepancy in delinquencies between securitized and retained loans. The effect of the other three capital ratios is even slightly higher. In a sense our results suggest that a sufficient level of capital rather than the originator's retained exposure is an effective tool for assuring careful bank lending. This result stresses the importance of the equity capital for incentives.

As a sensitivity analysis we also perform a random-effects estimation and report the results in Appendix B, Table 3.16. This estimator is more efficient than the fixed-effects estimator, but it is consistent only under the assumption that c_i is not correlated with the covariates. Throughout all the specifications the estimated coefficients of interest differ from those shown in Table 3.7. Therefore, we perform a Hausman's specification test, which allows the use of cluster-robust standard errors.[66] It indicates that fixed effects should be used since the null hypothesis that the random effects estimator is consistent is rejected.

3.8 Conclusion

Financial institutions in the USA have increasingly used securitization techniques since the beginning of the nineties. Prior to the financial crisis, the general wisdom on securitization was that it is an efficient tool that allows a

[66] The standard Hausman test assumes that the random-effects estimator is fully efficient. In the case that c_i and u_{it} are not i.i.d. this test is not valid. In our case this is indicated by the fact that after random-effects estimation the default standard errors differ considerably from the cluster-robust ones. Cameron and Trivedi (2009), pp. 261-262, and Wooldridge (2002), pp. 290-291, describe how one can conduct this test using a cluster-robust variance-covariance matrix.

better allocation of risks and enhances the resilience of the financial system. The onset of the current crisis has proved this view wrong and revealed some serious misalignments in securitization markets.

Using panel data on big US commercial banks we find robust evidence of banks using securitization techniques to relax regulatory capital constraints. In order to identify this effect empirically we solve the issue of reverse causality by using a corrected capital ratio measure. We further put emphasis on the different behavior of the extensive and intensive margins of securitization. While capital arbitrage drives both margins, lowering the debt financing costs via securitization seems to be only important for the scale of securitization activities.

Subsequently we focus on the incentives for prudent screening and monitoring of securitized loans by originating banks. Controlling for the heterogeneity of originators, loan portfolios, and other characteristics, we find evidence of significantly poorer performance of securitized loans compared with on-balance-sheet loans. Moreover, tools for overcoming incentive problems, like the retention of some of the risk in the securitized portfolio, seem to be ineffective. Finally, our empirical results support minimum capital adequacy regulation as a way to discipline originators to evaluate risk stringently. However, our research also suggests that loopholes in the current regulatory framework may have seduced banks to securitize assets only for the sake of avoiding holding regulatory capital. Such behavior can undermine the safety and soundness of the financial system.

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B Appendix to chapter 3

Table 3.8: Pairwise correlations of capital ratios

	Capital/RWA	**Capital/RWA Corrected**	**Tier1/Total Assets**	**Tier1/Total Assets Corrected**
Capital/RWA	1.00			
Capital/RWA Corrected	0.97	1.00		
Tier1/Total Assets	0.81	0.74	1.00	
Tier1/Total Assets Corrected	0.80	0.82	0.93	1.00

Table 3.9: Pairwise correlations

	Total Delinquencies of Retained Loans	**90 Days Past Due Retained Loans**	**First-Loss Piece**	**Retained Securitization Ownership**
Total Delinquencies of Retained Loans	1.00			
90 Days Past Due Retained Loans	0.85	1.00		
First-Loss Piece	0.05	0.01	1.00	
Retained Securitization Ownership	0.01	0.23	0.01	1.00

Table 3.10: Descriptive statistics

Variable	Obs	Mean	Std Dev.	Min	Max
Sample All banks					
Securitization Dummy	10553	0.06	0.23	0	1
Capital/RWA	10553	0.140	0.088	0	0.79
Capital/RWA Corrected	10549	0.138	0.087	0	0.79
Tier1/Total Assets	10553	0.095	0.061	0	0.52
Tier1/Total Assets Corrected	10549	0.092	0.055	0	0.49
Log of Total Assets	10557	14.58	1.49	8.35	21.07
Yield Loans and Leases	9978	0.07	0.02	0.04	0.22
Financing Costs	10053	0.02	0.01	0.005	0.05
Credit Risk (Loss Allowances)	10475	0.01	0.01	0	0.26
Investment Banking	10053	0.01	0.01	0	0.44
Tax Rate (in %)	10051	32.39	11.31	-5.16	60.83
Credit Card Bank	10740	0.04	0.20	0	1
Fed Funds Rate	10740	3.33	1.61	1	5.25
Baa Risk Premium	10740	2.07	0.47	1.56	3.38
Sample Securitizers (once during sample period)					
Securitized to Total Assets (gross)	1487	0.38	0.88	0	5.70
Securitized to Total Assets	1487	0.36	0.84	0	5.37
Total Delinquencies of Securitized Loans (in %)	1344	3.67	4.57	-0.01	45.59
Total Delinquencies of Retained Loans (in %)	1294	0.67	2.93	-17.44	20.89
90 Days and less Past Due Retained Loans (in %)	1340	1.59	1.57	0	27.86
First Loss Piece (share of outstanding amount)	1340	0.08	0.18	0	1
Retained Securitization Ownership (share of outstanding amount)	1340	0.05	0.14	0	1
Capital/RWA	2265	0.134	0.058	0	0.79
Capital/RWA Corrected	2261	0.124	0.048	0	0.79
Tier 1/Total Assets	2265	0.096	0.065	0	0.52
Tier1/Total Assets Corrected	2261	0.086	0.042	0	0.49
Sample Securitizers (new issuance only)					
Capital/RWA	610	0.142	0.064	0	0.68
Capital/RWA Corrected	610	0.116	0.044	0	0.49
Tier1/Total Assets	610	0.108	0.082	0	0.52
Tier1/Total Assets Corrected	610	0.082	0.039	0	0.43

Table 3.11: Pairwise correlations of explanatory variables

	Log of Total Assets	Yield Loans and Leases	Financing Costs	Credit Risk	Investment Banking	Tax Rate	Fed Funds Rate	Baa Risk Premium
Log of Total Assets	1							
Yield Loans and Leases	-0.20	1						
Financing Costs	0.04	0.45	1					
Credit Risk	-0.11	0.52	0.07	1				
Investment Banking	0.29	-0.15	-0.16	-0.05	1			
Tax Rate	0.10	-0.03	-0.06	0.05	0.04	1		
Fed Funds Rate	0.10	0.24	0.61	-0.09	-0.04	-0.01	1	
Baa Risk Premium	0.03	-0.06	-0.04	0.06	0.03	-0.02	-0.56	1

Table 3.12: The extensive margin of securitization: using Capital/RWA

Dependent Variable:	Securitization Dummy						
Estimation:	Pooled Probit						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital/RWA	0.11	0.37	0.26	0.10	0.18	0.22	0.24
	(0.74)	*(0.79)*	*(0.78)*	*(0.79)*	*(0.77)*	*(0.73)*	*(0.83)*
Log of Total Assets	0.41***	0.42***	0.40***	0.41***	0.39***	0.41***	0.41***
	(0.043)	*(0.043)*	*(0.043)*	*(0.043)*	*(0.044)*	*(0.043)*	*(0.043)*
Credit Card Bank	1.72***	1.28***	1.61***	1.47***	1.68***	1.67***	1.28***
	(0.26)	*(0.24)*	*(0.32)*	*(0.43)*	*(0.27)*	*(0.27)*	*(0.37)*
Yield Loans and Leases		4.98**					3.68
		(2.39)					*(3.89)*
Financing Costs			3.32				1.19
			(10.2)				*(11.3)*
Credit Risk (Loss Allowances)				6.66			4.36
				(8.18)			*(9.81)*
Investment Banking					4.70		4.65
					(3.45)		*(3.48)*
Tax Rate						-0.0089	-0.0092
						(0.0060)	*(0.0061)*
Fed Funds Rate							-0.13
							(0.12)
Baa Risk Premium							-1.20
							(0.85)
Quarter dummies	yes	yes	yes	yes	yes	yes	yes
Observations	8445	7875	7941	8372	7941	7939	7873
Number of bank clusters	506	503	506	503	506	506	503
Wald statistic	213	214	226	229	203	206	272
Pseudo R-squared	0.34	0.34	0.34	0.35	0.34	0.34	0.35

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Constant and quarter dummies are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3.13: The extensive margin of securitization: using Tier1/Total Assets

Dependent Variable:	Securitization Dummy						
Estimation:	Pooled Probit						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tier1/Total Assets	2.31**	2.42**	2.44**	2.41**	2.38**	2.37**	2.38**
	(0.99)	*(1.04)*	*(1.04)*	*(1.00)*	*(1.03)*	*(1.02)*	*(1.10)*
Log of Total Assets	0.43***	0.44***	0.43***	0.44***	0.41***	0.43***	0.43***
	(0.041)	*(0.042)*	*(0.042)*	*(0.042)*	*(0.043)*	*(0.042)*	*(0.043)*
Credit Card Bank	1.47***	1.09***	1.34***	1.22***	1.42***	1.42***	1.07***
	(0.27)	*(0.26)*	*(0.31)*	*(0.41)*	*(0.28)*	*(0.28)*	*(0.38)*
Yield Loans and Leases		4.28*					2.72
		(2.34)					*(3.72)*
Financing Costs			4.95				3.25
			(8.64)				*(10.0)*
Credit Risk (Loss Allowances)				6.25			4.64
				(7.66)			*(9.24)*
Investment Banking					4.48		4.51
					(3.54)		*(3.61)*
Tax Rate						-0.0088	-0.0088
						(0.0062)	*(0.0062)*
Fed Funds Rate							-0.13
							(0.12)
Baa Risk Premium							-1.19
							(0.86)
Quarter dummies	yes	yes	yes	yes	yes	yes	yes
Observations	8445	7875	7941	8372	7941	7939	7873
Number of bank clusters	506	503	506	503	506	506	503
Wald statistic	250	260	246	268	242	244	316
Pseudo R-squared	0.35	0.35	0.34	0.35	0.35	0.35	0.35

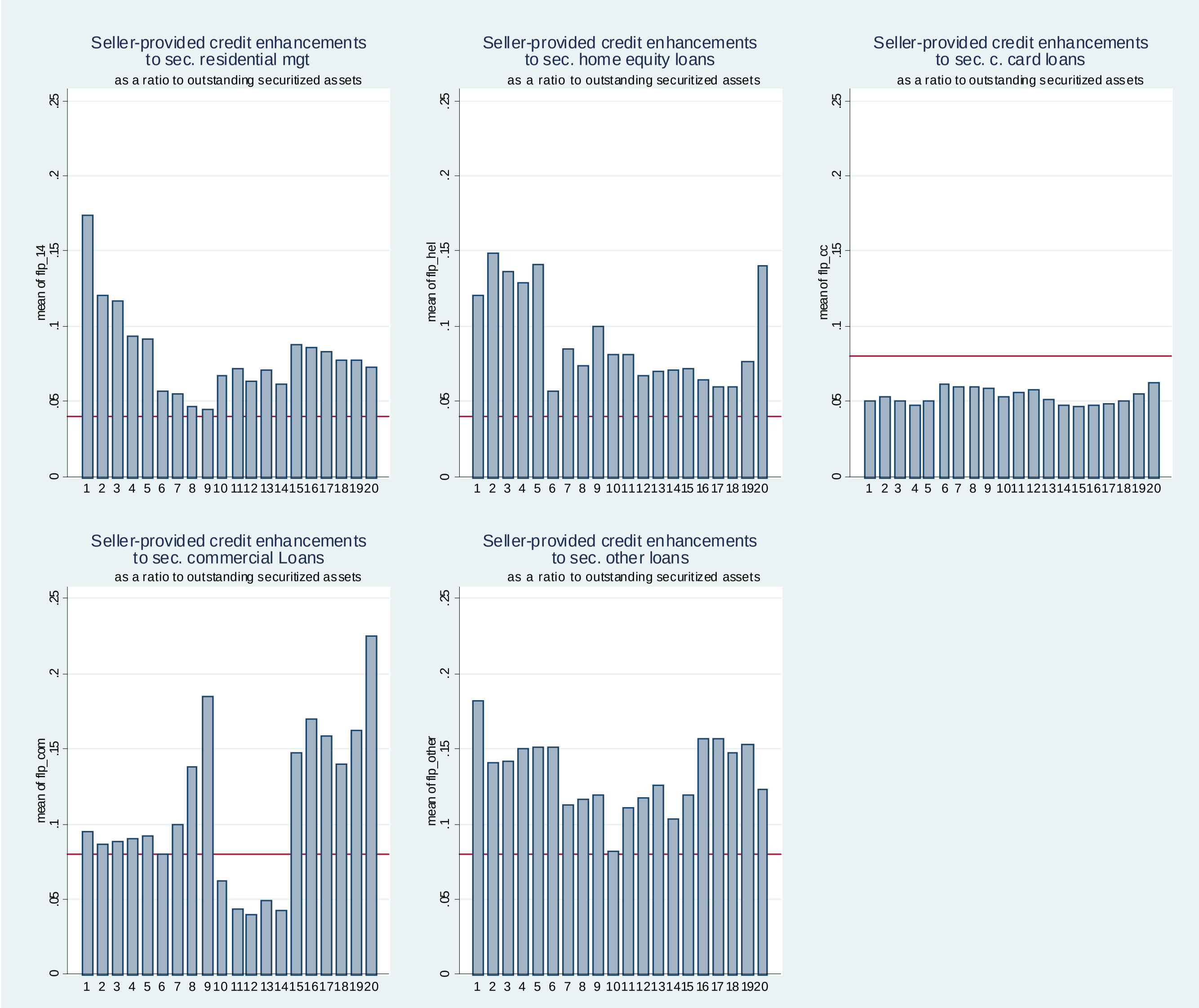
Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. Constant and quarter dummies are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 3.14: The intensive margin of securitization: random- vs. fixed-effects estimates

Dependent Variable:	Securitized to Total Managed Assets (gross)			
Capital Ratio:	Capital/RWA Corrected		Tier1/Total Assets Corrected	
Estimation:	RE	FE	RE	FE
	(1)	(2)	(3)	(4)
L1.(Securitized to Total Managed Assets)	0.96***	0.71***	0.96***	0.73***
	(0.029)	*(0.088)*	*(0.026)*	*(0.082)*
Capital Ratio	-0.17	-0.80	-0.13	-0.99
	(0.15)	*(0.52)*	*(0.16)*	*(0.66)*
Log of Total Assets	-0.0014	-0.073**	-0.0014	-0.081**
	(0.0013)	*(0.032)*	*(0.0014)*	*(0.036)*
Yield Loans and Leases	0.23	0.21	0.25	0.20
	(0.16)	*(0.16)*	*(0.17)*	*(0.16)*
Financing Costs	1.18**	1.61***	1.18**	1.81***
	(0.53)	*(0.55)*	*(0.53)*	*(0.63)*
Credit Risk (Loss Allowances)	0.36	-0.13	0.33	-0.069
	(0.26)	*(0.46)*	*(0.27)*	*(0.42)*
Investment Banking	0.065	0.00068	0.037	0.047
	(0.067)	*(0.038)*	*(0.044)*	*(0.051)*
Tax Rate	-0.00014	-0.000063	-0.00012	-0.000021
	(0.00017)	*(0.00018)*	*(0.00016)*	*(0.00016)*
Fed Funds Rate	-0.019*	-0.014	-0.018*	-0.012
	(0.010)	*(0.0093)*	*(0.0098)*	*(0.0078)*
Baa Risk Premium	-0.066	-0.067	-0.061	-0.056
	(0.055)	*(0.057)*	*(0.054)*	*(0.050)*
Credit Card Bank	0.0054		0.0056	
	(0.019)		*(0.018)*	
Quarter dummies	yes	yes	yes	yes
Bank fixed effects	no	yes	no	yes
Observations	1043	1043	1043	1043
Number of bank clusters	88	88	88	88
R-squared	0.98	0.69	0.98	0.70
Rho		0.97		0.97

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. The table shows random-effects (RE) and fixed-effects (FE) within estimates. Constant and quarter dummies are suppressed. Rho is the fraction of variance due to the fixed effects. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Figure 3.9: Seller-provided credit enhancements



Notes: Quarters denoted on the horizontal axis. 1 is the third quarter of 2003; 20 is the second quarter of 2008. The horizontal lines mark the 4% or the 8% thresholds.

Table 3.15: Mean comparison of delinquencies by type of loan and time past due

Residential first lien mortgages

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	.	.	.	.	0.18	0.17	.	.
sd	.	.	.	.	0.85	0.50	.	.
N*	0	0	0	0	709	709	0	0
min	.	.	.	.	-3.12	-0.21	.	.
max	.	.	.	.	12.01	6.39	.	.

Home equity loans

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	1.67	0.66	0.96	0.16	0.99	0.46	3.61	1.28
sd	2.66	0.67	1.57	0.18	1.87	0.92	5.55	1.53
N*	170	170	170	170	170	170	170	170
min	0.00	0.01	0.00	0.00	-3.43	-0.07	0.00	0.04
max	14.52	3.52	8.40	0.90	6.91	7.15	22.33	9.98

Credit card debt

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	1.85	1.95	1.49	1.55	4.71	4.21	8.06	7.70
sd	0.90	0.86	0.80	0.86	2.35	2.24	3.72	3.65
N*	304	304	304	304	304	304	304	304
min	0.00	0.00	0.00	0.00	0.00	-3.35	0.00	0.00
max	6.50	4.41	4.15	4.00	10.85	9.81	17.36	17.20

Commercial loans

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	1.01	0.79	0.88	0.42	1.17	1.14	3.07	2.35
sd	1.65	0.95	2.16	0.76	2.72	2.28	4.57	3.44
N*	153	153	153	153	153	153	153	153
min	0.00	0.00	0.00	0.00	-3.11	-0.41	-3.11	-0.16
max	8.56	8.52	18.36	5.19	9.73	10.35	18.36	15.36

Other loans

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	1.24	0.55	1.00	0.13	0.80	0.18	3.04	0.86
sd	1.70	0.51	1.50	0.19	2.29	0.31	4.37	0.72
N*	266	266	266	266	266	266	266	266
min	0.00	0.00	0.00	0.00	-1.24	-0.14	0.00	0.00
max	8.47	4.32	9.78	1.32	18.98	2.38	21.66	4.32

Total

	30 days past due		90 days past due		Booked losses		Total delinquencies	
	securitized	retained	securitized	retained	securitized	retained	securitized	retained
mean	1.39	0.96	0.81	0.30	0.51	0.17	2.71	1.42
sd	2.11	0.68	1.83	0.55	1.35	0.58	3.93	1.24
N*	1067	1067	1067	1067	1067	1067	1067	1067
min	0.00	0.00	0.00	0.00	-3.43	-3.29	0.00	0.00
max	19.97	4.89	25.87	10.43	12.01	5.50	39.86	14.31

Notes: N* denotes the number of time*bank observations. Sample statistics are computed for the sample that is not missing for any of the four variables within each type of loan.

Table 3.16: Total delinquencies of securitized loans: RE estimates

Dependent Variable:	Total Delinquencies of Securitized Loans							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total Delinquencies of Retained Loans	1.66***	1.65***	1.66***	1.65***	1.59***	1.57***	1.62***	1.61***
	(0.48)	*(0.48)*	*(0.48)*	*(0.48)*	*(0.41)*	*(0.40)*	*(0.44)*	*(0.44)*
First Loss Piece		2.19**		2.31**	2.21**	2.94***	2.08**	2.66**
		(1.08)		*(1.10)*	*(0.97)*	*(1.13)*	*(0.99)*	*(1.05)*
Retained Securitization Ownership			-0.51	-0.82				
			(0.57)	*(0.70)*				
Capital/RWA					-19.9**			
					(9.47)			
Capital/RWA Corrected						-23.7**		
						(10.6)		
Tier1/Total Assets							-18.0***	
							(5.15)	
Tier1/Total Assets Corrected								-24.6***
								(8.93)
Log of Total Assets					0.19	0.16	0.19	0.15
					(0.18)	*(0.18)*	*(0.17)*	*(0.19)*
Composition of securitized portfolio	yes	yes	yes	yes	yes	yes	yes	yes
Composition of retained portfolio	yes	yes	yes	yes	yes	yes	yes	yes
Quarter dummies	yes	yes	yes	yes	yes	yes	yes	yes
Bank fixed effects	no	no	no	no	no	no	no	no
Observations	1013	1013	1013	1013	1013	1013	1013	1013
Number of bank clusters	100	100	100	100	100	100	100	100
R-squared	0.27	0.26	0.26	0.26	0.27	0.28	0.28	0.27

Notes: Robust standard errors adjusted for clustering on the bank level in parentheses. The table shows random-effects GLS estimates. Controls for the composition of the securitized and the retained portfolio, quarter dummies and a constant are suppressed. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Chapter 4

Bank dividends in times of crisis[1]

[1]This chapter is based on a joint work with Katri Mikkonen, European Central Bank. Opinions expressed are those of the authors only and do not necessarily reflect the views of the European Central Bank.

4.1 Introduction

The year 2008 was marked by financial system stress. In the aftermath of the collapse of Lehman Brothers, the interbank market effectively stopped functioning. Banks felt unable to assess the creditworthiness of counterparts on the basis of balance sheet data and, as a consequence, they began to hoard excess liquidity. The perceived banking system instability was reflected in a dramatic plunge in the market capitalization of banks in 2008. It also led to extensive intervention by governments and central banks to prevent a meltdown of the financial system.

In that same period of turmoil, the ratio of aggregate bank dividends to aggregate bank profits increased significantly both in the United States and the European Union. In this paper we aim to identify what has driven the observed surge and assess how dividend payout policies of banks affected the stability of the banking system during the financial market turmoil. In so doing we take into account how dividend payouts relate to bank capital levels, profitability and risk.

Using balance sheet data on banks operating in the United States and in the European Union, we find no evidence for clearly imprudent dividend payout behavior. The data suggests that banks which received state capital injections in the United States significantly changed their payout policies toward less dividend smoothing and higher sensitivity to credit risk. Their competitors which were not directly supported by government aid, in contrast, did not significantly adjust their behavior. Dividend levels paid by them seem to have been adjusted rather slowly and gradually to the sharp profitability shock, a phenomenon which, in the short run, leads to capital leaks out of the banking system. Our results based on the European data indicate that credit institutions begun to consider the level of credit risk more strongly when taking decisions about dividend payout. However, we also find some evidence for stronger dividend smoothing during the crisis period compared to the period before.

The surge in dividend payout ratios has not been connected with excessive dividend payments by credit institutions with very low capital buffers or subject to high credit risk. However, dividend smoothing continued during the crisis and contributed to the pro-cyclicality of the financial system. Consequently, regulatory action to restrict dividend payments for banks that have low capital buffers may improve the social welfare in terms of systemic stability.

The paper is structured as follows: Sections 4.2 and 4.3 first discuss the stylized facts and the policy debate they have induced. Section 4.4 then briefly summarizes the related literature. Section 4.5 describes the datasets we use and provides statistics on bank dividend policies over time. We subsequently present the empirical model, and the results of the econometric analysis for the United States and European Union in Sections 4.6, 4.7 and 4.8. Section 4.9 concludes.

4.2 Background

The first signs of the financial crisis emerged in the second quarter of 2007, as Standard and Poor's and Moody's downgraded a number of sub-prime mortgage-backed securities. The downgrades continued in the third quarter of 2007, and Bear Stearns had to liquidate two of its hedge fonds which had invested heavily in mortgage backed securities. In the last quarter of 2007, the financial market pressure intensified further, most visibly reflected in an unprecedentedly high level of the LIBOR-OIS spread. The financial crisis reached its height in the aftermath of the default of Lehman Brothers in September 2008. So far, 181 banks have failed in the United States in the course of the crisis.[2] In comparison, the respective number after the burst of the dot.com bubble in 2001 was 18.

Governments and central banks intervened extensively to prevent a meltdown of the financial system. Besides interest rate cuts to the lowest historical levels by key central banks and fiscal stimuli to dampen the adverse effect of the crisis on the real economy, exceptional measures to stabilize financial

[2]See the failed bank list of the Federal Deposit Insurance Corporation (2010) (cut-off date 18.02.2010) and the financial crisis timeline, Federal Reserve Bank of Saint-Louis (2010). The number excludes institutions which have been acquired by competitors.

markets were taken. To strengthen the capital base of ailing banks, the US Department of Treasury injected USD 204.6 billion, or approximately 1,4% of the GDP, into the banking system.[3] In the European Union, capital injections amounted to EUR 170 billion, or 0.5% of GDP.[4] Furthermore, the minimum deposit insurance limits were increased from EUR 20.000 to EUR 50.000 in the European Union;[5] and from USD 100.000 to USD 250.000 in the United States. Finally, governments guaranteed other bank liabilities, established assets support schemes and temporarily prohibited naked short selling of bank shares.

In that same period of turmoil, the aggregate dividend payments of banks relative to their aggregate net income increased significantly both in the United States and the European Union, see Figures 4.1 and 4.2. The ratio appears to have been quite stable for the US sample for 2003-2006, varying between 40% and 60%, and hitting the 100% threshold only in the last quarter of 2006. The upper panel of Figure 4.3 reveals that this quarter was remarkably profitable.

The fraction of aggregate net income paid out to shareholders in the United States increased slowly during 2007, as the first signs of the crisis emerged, and then markedly rose up to over 200% in the last quarter, when the turmoil intensified. Aggregate dividend payments also exceeded the profits in the second and third quarters of 2008. Following the bankruptcy of Lehman Brothers in the third quarter of 2008, aggregate dividends of the US banks in the sample continued to exceed aggregate profits until the end of the sample period.[6] Figure 4.2 shows that the pattern observed in the European Union is similar: aggregate dividends relative to bank profits increased

[3] This action is known under the title of the Capital Purchase Program of the Troubled Assets Relief Program (TARP). For more information, see the financial crisis timeline by the Federal Reserve St. Louis, available at `http://timeline.stlouisfed.org/`, and the TARP Transactions Report 04/02/2010, United States Department of Treasury, Office of Financial Stability (2009).

[4] see Table III.2.1 in European Commission (2009).

[5] A further raise of up to EUR 100.000 is planned by end-2010. This additional increase will take place unless the European Commission in its impact assessment deems it financially not viable for some Member States.

[6] The two negative values in the fourth quarter of 2008 and the second quarter of 2009 arise because negative aggregate losses coincide with positive dividend payments.

considerably in 2008 when compared to historical standards.

To better understand what has driven the observed the surge in the ratio, Figure 4.3 depicts the development of the two variables for the US sample.[7] Whereas profits fell unexpectedly sharply in the fourth quarter of 2007 and did not recover until the third quarter of 2009, dividend payments decreased only gradually until the second quarter of 2009. Consequently, dividends paid between the fourth quarter of 2007 and the third quarter of 2008 were still comparable to those in 2004-2005, even though profits remained far below the levels generated at that time. Dividends dropped significantly only after the collapse of Lehman Brothers and returned to pre-crisis levels in the third quarter of 2009.

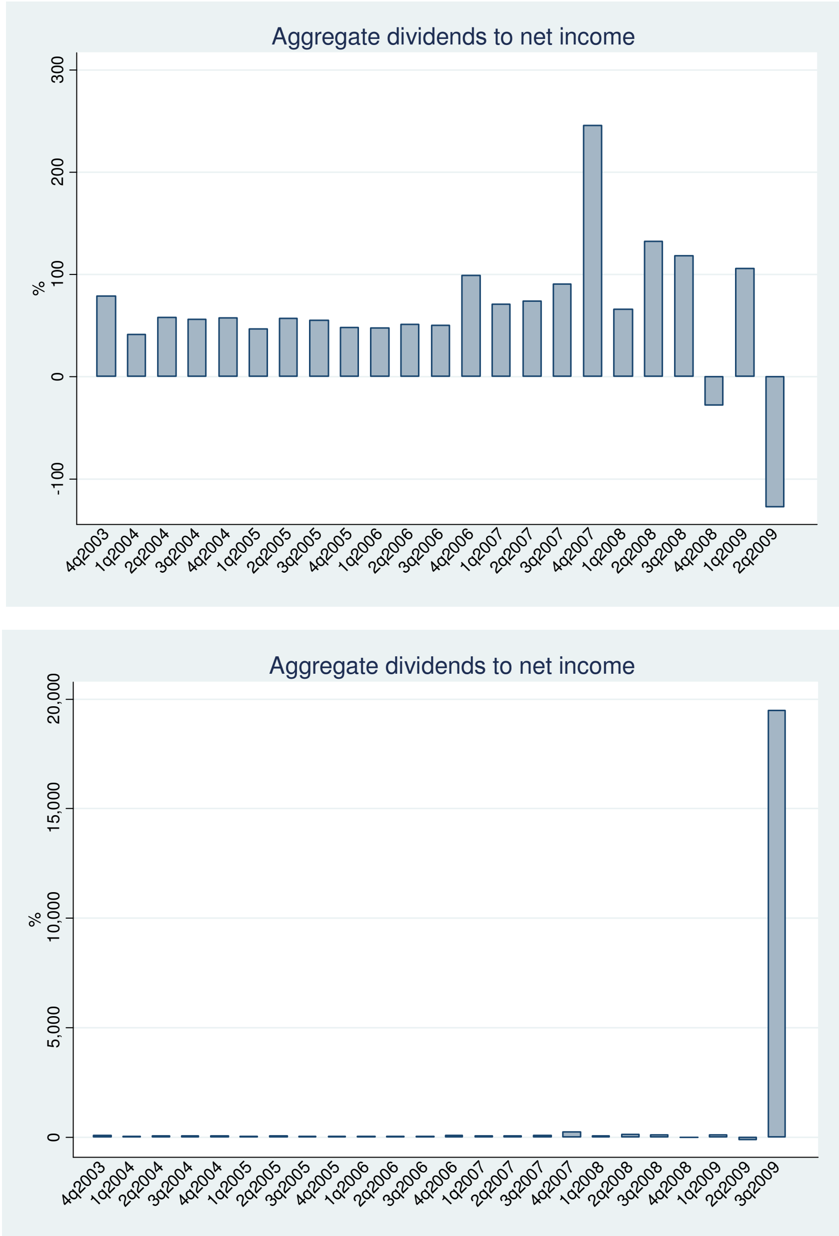
4.3 Current regulatory debate

The observed aggregate pattern does not necessarily imply that ailing banks have been remunerating shareholders at the expense of deposit insurance and senior debt holders. A careful assessment should take into account how the payout relates to bank capital, profitability and risk in the cross-section. The recent events have nevertheless induced comments by policy makers on both sides of the Atlantic. Concerns have been expressed that capital may be leaking out of the banking systems via dividend payments.[8][9] Some have suggested that by paying dividends, banks attempt to signal strength in the middle of the crisis, but in the end are weakening their position with the

[7] We do not present a similar graph for the EU sample due to its unbalancedness. The number of available observations per year for the EU varies significantly. Therefore, changes in the aggregate would arise not only due to changes in dividends and profits, but also due to changes in the number of observations used to compute the aggregates.

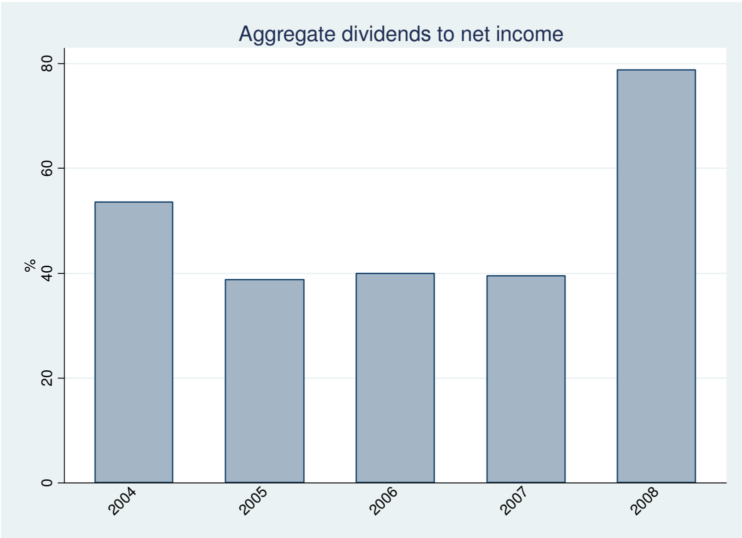
[8] See e.g. J.-C. Trichet (2009) and Hildebrand (2009).

[9] The Bank of England has made an effort to quantify the capital leak for the United Kingdom. According to the exercise, restricting UK banks from paying dividends in the event of annual losses between 2000 and 2007 would have left GBP 15 billion more in their balance sheets. In a similar vein, reducing staff costs by around one tenth and dividend payout rates by around a third would have allowed UK banks to increase retained reserves by close to GBP 70 billion over the next five years, boosting core Tier 1 ratios by 100 basis points, see Bank of England (2009) and Haldane (2010).



Notes: Author's calculations using data from the UBPR, based on a sample of the 506 largest commercial banks in the USA in 2q2008.

Figure 4.1: Ratio of aggregate dividends to aggregate net income in the United States



Notes: Author's calculations using data from BvD Bankscope, based on a sample of the 287 credit institution in the EU27.

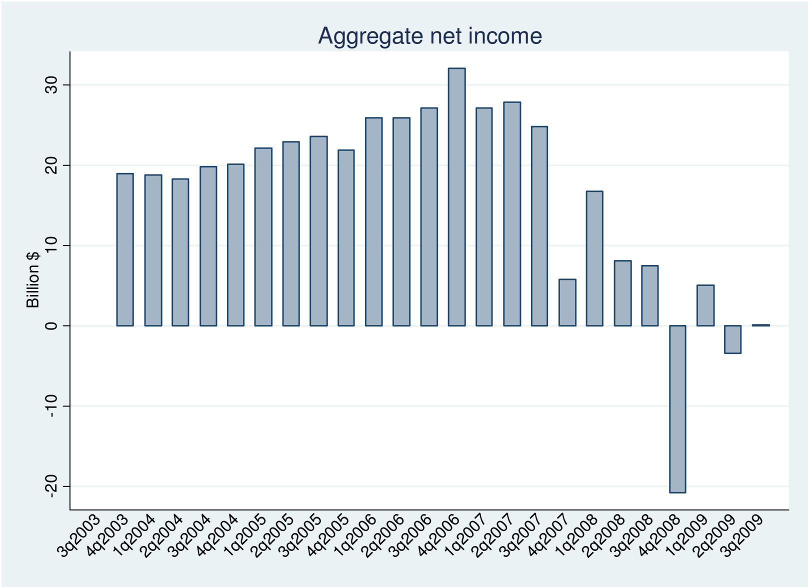
Figure 4.2: Ratio of aggregate dividends to aggregate net income in the European Union

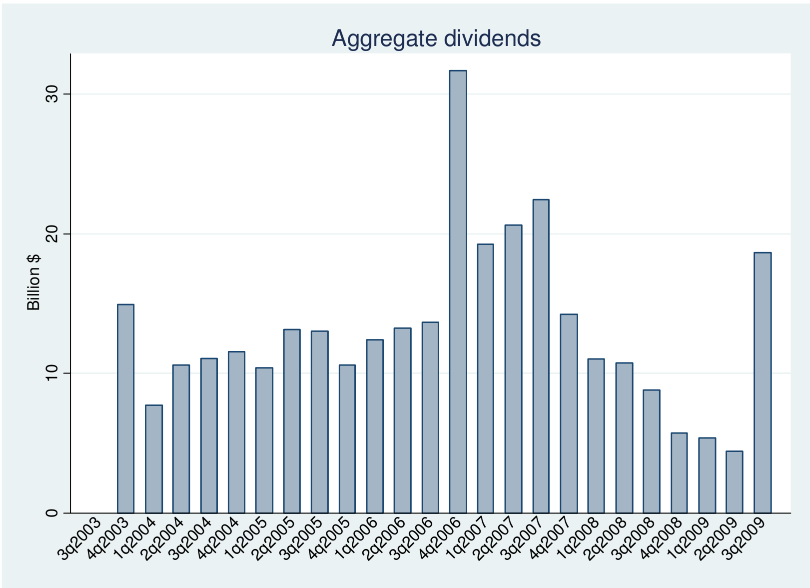
action.[10] These arguments have been matched with similar contributions among the academic writers, for instance by Acharya et al. (2009).

The concerns that capital may be leaking out of the financial system have given rise to recent proposals to restrict dividend payments via regulation. In connection with the overhaul of the global regulatory and supervisory framework that is taking place under the auspices of the Group of Twenty, the Basel Committee has proposed that retained earnings of banks should increase the closer their actual capital levels fall towards the minimum requirement. The aim of this measure would be to mitigate the impact on the procyclicalilty of the financial system that paying dividends in a situation of deteriorating financial conditions can have. A more comprehensive proposal is expected in July 2010, with possible implementation by end-2012.[11]

Finally, dividend payments are currently restricted for banks that receive government support. For banks participating in TARP in the United States, dividend payments on either junior preferred shares, preferred shares with

[10]See e.g. Dudley (2009) and the Basel Committee (2009).
[11]See Basel Committee (2009).





Notes: Author's calculations using data from the UBPR, based on a sample of the 506 largest commercial banks in the USA in 2q2008.

Figure 4.3: Aggregate net income and dividends in the United States

equal ranking to the TARP shares, or common shares can be made only after dividends to the Department of Treasury have been fully paid. In Europe, many of the EU Member States have conditioned their state aid to a stop on dividends in line with the recommendations of the European Commission and the Eurosystem. The Commission, which is responsible for the assessment of the banks' restructuring plans, clearly states in its guidelines that state aid should not be used to pay dividends.[12]

4.4 Related literature

Literature on dividends has had to depart from the frictionless world of Miller and Modigliani (1961), where dividend policy per se is irrelevant and where the firm maximizes value by simply distributing the entire free cash flow.[13] Empirical works have identified several stylized facts. Firms smooth dividend payments, a general observation across industries that was present in the influential survey of Lintner (1956), and that has been recently reproduced in the update of Brav et al. (2005). Firms seem to target the level of dividends paid or a growth rate, rather than a payout-earnings ratio, and they seem to be extremely reluctant to cut dividend payments. Applied to banking, and as noted by the Basel Committee (2009), this might exacerbate the pro-cyclicality of the banking system. Empirical evidence for dividend smoothing and the weak relation between earnings and dividends can be found in DeAngelo and DeAngelo (1990), DeAngelo et al. (1992), and Skinner (2008), among others.

[12] The recommendations of the ECB on government guarantees for bank debt, on the pricing of recapitalizations and guiding principles for bank asset support schemes are available at `http://www.ecb.europa.eu/pub/pub/prud/html/index.en.html`. See also in particular Article 26 in the Commission Communication on the return to viability and the assessment of restructuring measures in the financial sector in the current crisis under the State aid rules, Official Journal of the European Union, C195 of 19.8.2009, available at `http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009XC0819(03):EN:NOT`.

[13] See also Brennan (1971) and Rubinstein (1976). Free cash flow can be defined as being in excess of cash flow that is required to finance all positive net present value projects above the cost of capital (Jensen 1986). DeAngelo et al. (2008) provide a comprehensive overview on research on dividend payout policy.

Variation across firms may arise because of differences in the maturity of the company in question, or be explained by so-called clientele effects.[14] In particular in relation to financial distress, loss-making banks are the only ones that resist the incentive to smooth dividends and usually do not pay dividends at all (DeAngelo and DeAngelo 1990 and DeAngelo et al. 1992).

Nevertheless, the recent crisis seems to have made an exception, as large dividend to net profit ratios have been paid out at the height of financial distress. Acharya et al. (2009) in particular criticize banks for not conserving the capital in times when it is needed the most. Basel Committee (2009) and others have lately referred to the possible use of bank dividends as a signaling device.

Theoretical literature on dividends as a signaling device can be tracked back to Bhattacharya (1979).[15] Empirically, the information content of dividends has been contested. Besides the the majority contributions that have not found any information role for dividends,[16] DeAngelo et al (1992) in contrast show that knowledge on a dividend reduction improves the predicting power of the current earnings on the future ones. Benartzi et al. (1997) show that an increase in dividends increases the likelihood of a firm not to experience a drop in future earnings. Hanlon et al. (2007) find evidence that dividends convey information about future earnings, as the current returns of dividend-paying firms are more associated with future earnings than returns of firms that do not pay dividends. Also Lettau and Ludvigson (2005) contest the view that dividends would not convey information on future returns by showing that dividend forecasts positively covary with changing forecasts of excess stock returns over the business cycle.

[14]These arise when certain groups of shareholders prefer receiving dividend payments to returns based on share price increases. Typically these are thought to be retail investors which face high tax rates on dividend income and some special types of institutional investors. Some countries might also be more inductive to dividend payouts because of their legal systems and their influence on corporate governance. See Allen et al. (2000) and LaPorta et al. (2000).

[15]In a model with outside investors having imperfect information on profitability and a higher tax on cash dividends than on capital gains, dividends become a signal of future cash flows. See also Miller and Rock (1985) and John and Williams (1985).

[16]See e.g. Watts (1973), LaPorta et al. (2000), Skinner (2008), and Leary and Michaely (2008).

Signaling via dividends may make sense in particular in times of crisis. Bank managers might be revealing their expectations that losses are temporary.[17] Signaling such expectations in a credible way, whether true or not, may have been reasonable in a situation of total loss of confidence that faced an entire sector. The financial crisis might also have damaged the credibility of other channels for the banking industry, rendering dividend policy a more effective or a more credible supplementary tool.[18]

Alternatively to explanations related to the information content of dividends, agency theories provide some rationales for why dividends are paid despite the ongoing crisis. Especially for the banking industry, the limited liability may induce banks to pay high dividends to reduce shareholder risk inherent capital buffers if they are close to a possible bankruptcy.[19] The pecking order model of Myers and Majluf (1984) and Jensen (1986) propose that managers have an incentive to delay or to restrict dividend payouts in order not to forego profitable investment opportunities that may arise, or in order to gain more power over resources and let the firm grow to reach a size that is socially sub-optimal but compatible with the managerial incentives. Dividend payouts in such a situation can serve as a self-restrictive or shareholder tool to reduce resources under management control. La Porta et al. (2000) find evidence that investor pressure in countries with good minority shareholder protection is successful in inducing dividend payments by firms. Also Leary and Michaely (2008) find empirical support for agency consideration theories, given the types of firms that tend to smooth dividends the most.[20]

[17]DeAngelo et al. (1992) have found out that bank managers do not omit or reduce dividends in particular when they expect losses to be temporary.

[18]Bhattacharya (1979) also points out that other channels, such as accountants' reports, may be subject to moral hazard. Relatedly, DeAngelo et al. (1992) conjecture that the information content of dividends increases in situations where current earnings are unusual or extreme and therefore represent an unreliable indicator of future earnings.

[19]This phenomenon is related to the so-called gambling for resurrection, which was arguably present in the savings and loans crisis in the United States. See e.g. Dewatripont and Tirole (1993).

[20]Dividends are smoothed more often by larger firms, firms with slower growth prospects, firms with more tangible assets and with lower price volatility and earnings, and firms with more significant presence of institutional investors. These attributes combine

In particular in times of crisis, agency costs may have been increased with the increased volatility, and therefore decreased predictability, of free cash flow that the manager can invest in projects (Stulz 1990). Alternative explanations for high payouts during the crisis include managerial incentives to keep equity valuation high in order to avoid takeovers at low price, and building a reputation for treating investors fairly in order to be able to sell future equity at high prices. [21]

The considerations stated above give rise to our hypotheses in Section 5. Before we go into the model, however, we briefly present the data used in the estimations and perform some preliminary summary statistics.

4.5 Data description and summary statistics

The data for the United States comes form the Uniform Bank Performance Report collected by the Federal Deposit Insurance Corporation.[22] Our sample comprises the income statements, the balance sheets and data on the regulatory capital of the 506 largest commercial banks operating in the United States, with total assets exceeding USD 1 billion in the second quarter of 2008. We have quarterly data for the period between the fourth quarter of 2003 and the third quarter of 2009, and yearly data from 1998 to 2008.

The data for the European Union is obtained from the Bureau van Dijk's Bankscope Database. The data comprises consolidated yearly income statements, balance sheets and regulatory capital of commercial, savings and cooperative banks established in one of the 27 EU Member States.[23]

The US sample is balanced in the sense that we have information on dividends for all banks in all periods. The variations in available bank observations over time arise because 42 of the 506 banks operating in the second quarter of 2008 failed in the course of the crisis, and because 22 new in-

well with hypotheses that support agency theories.

[21] See e.g. Schleifer and Vishny (1997), Fluck (1998) and Gomes (2000).

[22] The data is available at the Federal Financial Institutions Examination Council webpage at `http://www.ffiec.gov/ubpr.htm`.

[23] Dependent subsidiaries of institutions in the sample are consolidated if the stake of the mother company is more 50%.

stitutions were founded between end-2004 and mid-2008.[24] In contrast, the European dataset is highly unbalanced, with data on less than 150 banks for 2002-2003 and between 350 and 480 credit institutions for 2004-2008. In addition, focusing our attention on banks for which data on dividends is available reduces the sample to a total of 287 banks. For the summary statistics and graphs we use data starting from 2004, as the sample composition is more stable for this period.

When interpreting the results of our analysis, one should note that the US sample contains only large banks and that small banks are strongly under-represented in the European sample. The results therefore apply to large banks and do not capture the behavior of small banks that possibly follow different business strategies. Owing to the high concentration in the banking market, our sample nevertheless covers 77% of bank assets in the United States in 2008.[25]

We in addition gathered information on state recapitalizations of banks in our samples. For the USA, data was available from the TARP Transactions Report of the Department of the Treasury.[26] The report comprises data on the name of the recapitalized bank, the amount of funds provided and the dates of provision and repayment of funds. For the European sample, we used the European Commission's Overview of national measures, which lists the names of banks supported by national authorities on an ad-hoc basis and the date the Commission has adopted a decision regarding the action.[27]

Figures 4.4 and 4.5 show how the mean of the dividend to net income ratio evolved over time in the United States and the European Union. The upper panels of the figures display the dividend payout ratios for banks with

[24]Table 4.8 in Appendix C provides an overview of observations available over time for both the US and EU samples. We provide further summary statistics in Appendix C in Tables 4.10, 4.11, 4.12, and 4.13.

[25]See Table 4.9 in Appendix C.

[26]We used the 04/02/2010 TARP Transactions Report, United States Department of Treasury, Office of Financial Stability (2009).

[27]European Commission (2010), memo/10/52, 26.02.2010. We are fully aware that this list may not be comprehensive. However, no complete listing is published to our knowledge. In this regard, the challenges in Europe are multiplied in comparison to the United States, simply because of the existence of several sovereign states within the economic area.

positive profits, and the lower panels of the figures show the same for banks that have incurred losses. Splitting the samples along profitability is essential, as an increase in the dividends paid to shareholders ceteris paribus leads to a higher dividend payout ratio for banks with positive profits. Thus, high dividend payout ratios for these banks indicate that more capital is paid out in the form of dividends. For banks which incur losses the relation is, however, opposite, as an increase of dividends leads to a higher but negative payout ratio. By splitting the samples we can attribute an increase in the observed mean of the payout ratio for banks with positive net income to banks that are allocating profits to remunerate shareholders. Similarly, for banks making losses, one can attribute the drop in the observed mean to higher average dividends relative to (negative) net income.

Cross-checking the evolution of the cross-sectional means over time with the observed aggregate patterns allows us to rule out that the increase in the aggregate dividend payout ratio solely reflects the effect of big losses incurred by a small group of banks. An increase in the aggregate ratio could emerge if a group of banks incurs high losses and cuts dividends to zero, while the remaining banks with stable and positive profits continue paying a constant fraction of net income to shareholders. The losses incurred by the first group of banks would lower the aggregate net income. The aggregate dividend series would not drop proportionately as the dividends paid by unprofitable banks cannot and would not become negative. As a result, the observed aggregate ratio of dividends to net income would increase, despite prudent behavior of all banks.

The evolution of the payout ratios in the United States, as depicted in Figure 4.4, shows that the average ratio of dividends to profits is relatively stable for profitable banks until the end of 2006.[28] In contrast, banks which had incurred losses canceled dividend payments prior to the crisis. The average dividend to net income ratio for this group is zero most of the time

[28]Dividends are paid in the United States for most of the companies in the form of regular quarterly dividends. One can easily spot an end-of-the-fiscal-year effect leading to higher payout ratios in the fourth quarter compared to other quarters during the same year.

until mid-2007. The ratio of dividends to profits for profitable banks seems to have started rising gradually in 2007. The increases gather momentum in the course of 2008 and reach a peak in the last quarter of 2008, at the height of the financial crisis. Contrary to their earlier behavior, many of the banks incurring losses now also paid dividends.[29]

The pattern observed in the European Union in Figure 4.5 is similar, albeit somehow less prominent.[30] Banks with positive profits paid on average over 50% of net income to shareholders at the end of 2008. In the years prior to 2008, the payout ratio amounted to approximately 40%. Banks in the European Union have been equally reluctant to cut dividends to 0 when losses have materialized, not only in 2008 but also in the previous years.

Obviously, both banks with positive profits and banks incurring losses in the European Union and in the United States have been reluctant to cut dividends at the same rate at which profits dropped during the crisis. The average retained income decreased both because profits decreased and because a higher fraction of them was paid out to shareholders. The pattern observed at the aggregate level is clearly not the pure result of losses incurred by a small group of banks, but reflects a broader increase in the fraction of profits paid out.

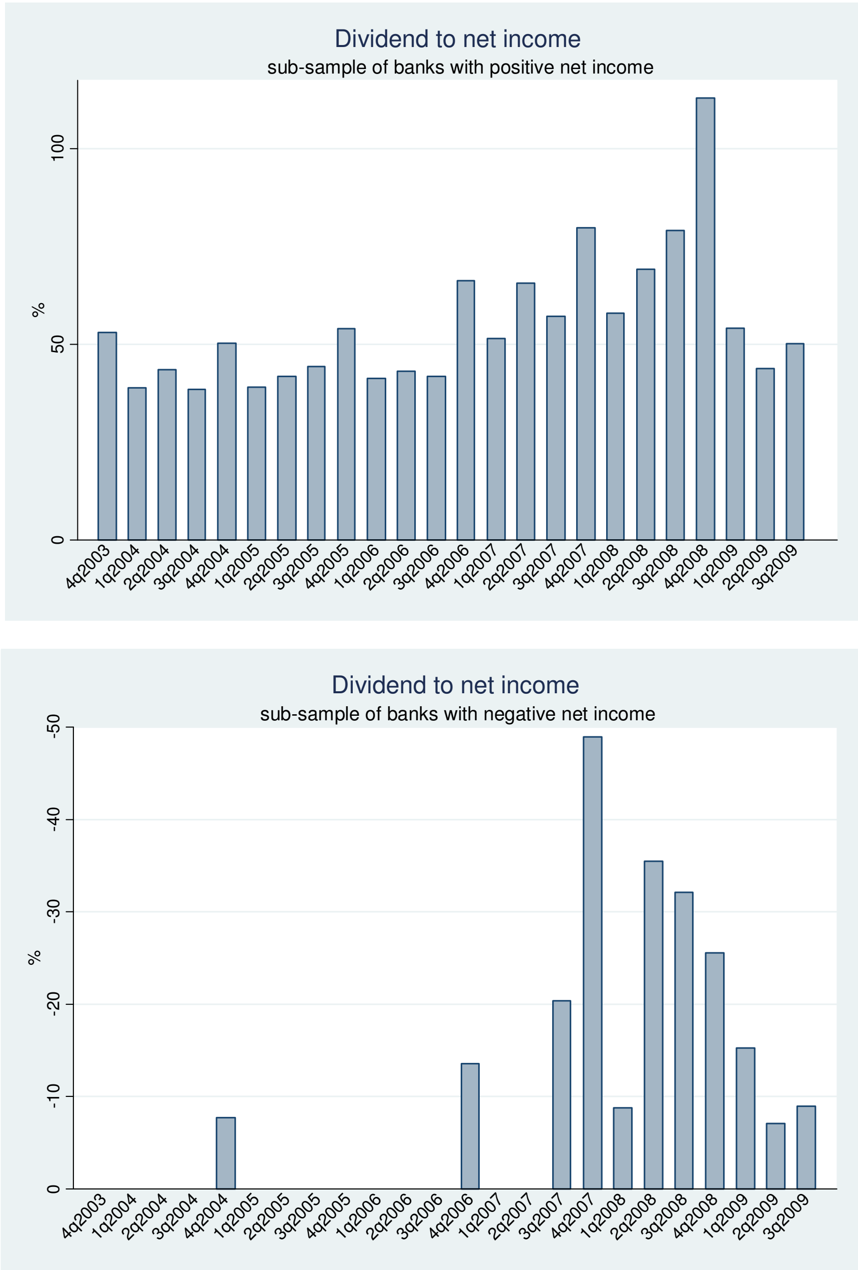
Nevertheless, to be able to understand the observed pattern, the relation of dividend payouts to bank characteristics in the cross-section and their possible change in the course of the crisis need to be taken into account.

4.6 Empirical model

The research question we investigate empirically is: What determines the fraction of profits paid out to shareholders? And second: Did a shift in dividend policy occur during the crisis?

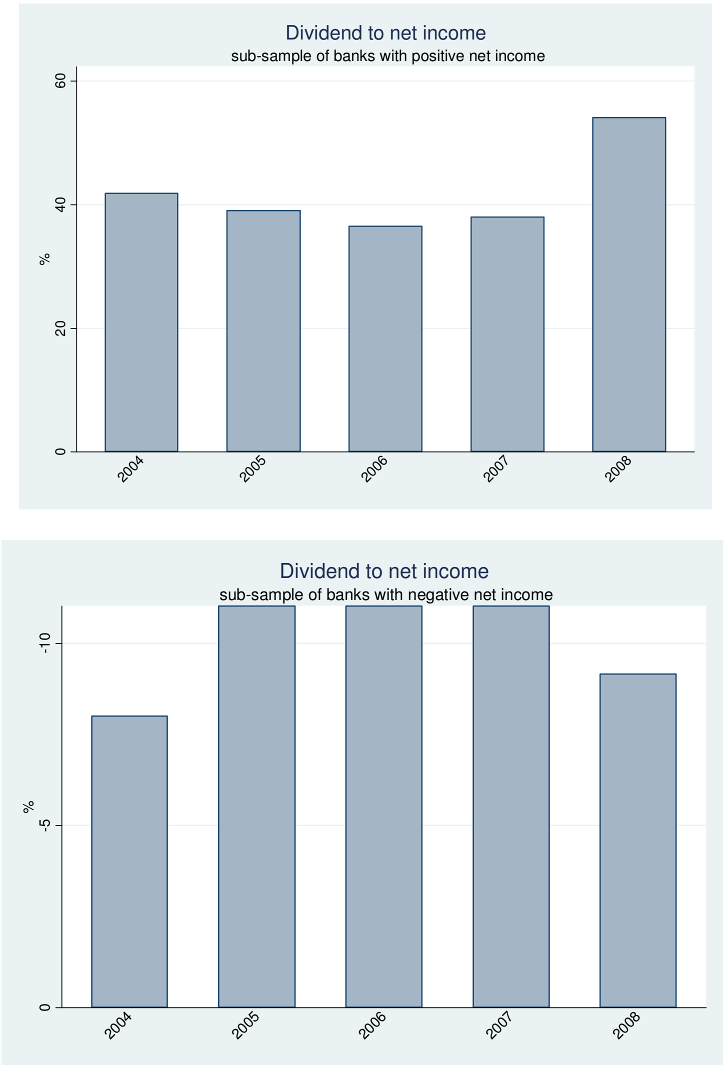
[29]See also Table 4.14 in Appendix C.

[30]Dividend payments in most of the EU countries are made once a year, after the annual meeting of shareholders. Thus, the availability of data on annual frequency does not lead to a loss of information for our European sample.



Notes: Author's calculations using data from the UBPR, based on a sample of the 506 largest commercial banks in the USA in 2q2008.

Figure 4.4: Mean of the dividend to net income ratio in the United States



Notes: Author's calculations using data from BvD Bankscope, based on a sample of the 287 credit institution in the EU27.

Figure 4.5: Mean of the dividend to net income ratio in the European Union

Using the ratio of dividends to net income as the explanatory variable is an intuitively appealing way to approach the issue, as a higher ratio normally indicates a higher fraction being distributed to the shareholders. This logic, however, does not apply to loss-making banks, for which a lower, negative, ratio indicates higher dividend payouts.

Given that such negative observations cluster in the period of the financial crisis,[31] not accounting for this reversed relation could lead to misleading estimates for a shift in payout policy during this period.[32]

To account for this effect, we adjust the ratio in the following way. We use the standard payout ratio for dividend payments connected to a positive profit. If, however, a bank pays dividends despite losses, we adjust the ratio to equal to $(dividend + |netincome|)/|netincome|)$.

$$\begin{aligned} adj.\ div.\ ratio_{it} &= \quad 0 && \text{if } dividend_{it} = 0 \\ &\in \quad (0,1] && \text{if } dividend_{it} \leq profit_{it} \\ &> \quad 1 && \text{if } dividend_{it} > profit_{it} \end{aligned} \tag{4.1}$$

The adjusted dividend payout ratio now equals 0 if banks cease dividend payments. Thus, the ratio is the lowest for banks which do the best to strengthen their capital base. For a bank with positive net income, the ratio ceteris paribus increases when dividend payments go up. If dividends exceed profits, equity is reduced and the ratio becomes greater than one.

In a similar vein, dividend payments by loss-making banks ceteris paribus lead to a direct leak of equity capital.[33] The adjusted ratio for these institu-

[31] See lower panel of Figure 4.4 and Table 4.14 in Appendix C for the US sample.

[32] To illustrate how such a bias may emerge, assume for the time being that high capital ratios ceteris paribus lead to high dividend payouts. Before the financial crisis, negative payout ratios were hardly observed, and therefore a true positive marginal effect of capital on dividend payout can be found by regressing the dividend payout ratio on the equity ratio and appropriate control variables. For the crisis period, however, the same regression would give lower estimates of the marginal effect, even if no true change in payout policy had taken place. On average, the correlation between capital and dividends becomes weaker for this period, because for the significant number of loss-making banks the relation between these ratios for would be the opposite: high capital buffers would tend to coincide with higher dividend payments, which lead to higher in absolute terms but negative dividend payout ratios.

[33] Additional to the loss of equity due to negative net income.

tions is also greater than one. Thus, we argue that it captures the effect of dividends on equity capital in a meaningful and monotonic way.[34]

For our regression analysis we use the following explanatory variables:

- **Capital base**: We expect that banks with large capital buffers will ceteris paribus pay out a higher fraction of profits. In the line of argument of Myers and Majluf (1984), high capital buffers decrease the risk of becoming capital constrained and having to subsequently incur high flotation costs of new equity issuance after dividends payouts. A large capital base should further lead to a distribution of a higher fraction of profits to shareholders, in order to minimize any agency costs of free cash flow in the meaning of Jensen (1986).[35] Additional rationales would include bank managers building up a reputation of prudence and fairness to investors to achieve more favorable terms of capital issuance, as in Shleifer and Vishny (1997) and LaPorta (2000).

[34]An alternative way to pursue this kind of analysis would be to run regressions of the levels of dividends on the levels of profits and other explanatory and control variables.

The approach has several caveats. The most severe one is the possibility of a spurious regression as all variables in levels could follow a time trend. Given the fact that we have a panel data set with a time dimension of 24 periods only, we cannot use time series methods to distinguish between causality and pure correlation. Including time dummies cannot fully remedy the problem.

Moreover, all variables obviously depend on the size of banks. Larger banks naturally generate higher profits and pay higher dividends; they invest higher amounts of money in risky projects, as they manage bigger portfolios and, thus, need to build up higher reserves for losses on loans and leases. In the same way, large banks on average incur higher losses. Size alone, however, does not imply that the profitability per unit invested is high or risk per unit is excessive. In a way, the regression of levels on levels could give us a trivial and possibly spurious result.

To remedy the problem with levels one could use growth rates instead of levels, as often done in time-series models. The approach is, however, not suitable for our data set, as a number of banks cancel dividends to zero during the crisis period. Calculating growth rates is therefore mathematically impossible for these institutions.

Thus, we decided not to use levels or growth rates in our regression analysis.

[35]In the sense of Jensen (1986), free cash flow is the hypothetical fraction of profits that remains after all positive net present value projects have been undertaken. Management may be seduced to use such free cash flow to, for example, fund negative-present-value pet projects. Thus, shareholders are better off if the free cash flow is entirely distributed to them. In a way, the full distribution is a commitment devise that no unprofitable projects are undertaken.

For the US sample, capital abundance is measured by either the ratio of regulatory capital to risk-weighted-assets or the ratio of equity to total assets. For the EU sample, we use only the ratio of the balance sheet equity to total assets because we do not have data on regulatory capital for all institutions. We use lagged values of capital ratios to rule out endogeneity problems.[36]

- **Profitability**: We expect that high profitability ceteris paribus leads to a higher adjusted dividend payout ratio. The hypothesis relies again on the free cash flow argument. Assuming that the amount of earnings earmarked for retention rather depends on a bank's capital and risk, an increase of profits of one unit leads to a one-to-one increase of free cash to be distributed, which should lead to a higher dividend payout ratio.[37]

  If dividend smoothing takes place in the banking industry, the relation between profitability and dividend payout ratio would be the opposite: Higher than average profits would lead to a lower dividend payout ratio, as banks would be reluctant to increase dividends to an unsustainable level. We use return on assets as a measure for profitability.[38]

- **Losses**: We include a dummy variable that equals one if a bank has incurred a loss in the reporting period and zero otherwise. The loss dummy allows a better identification of the effect of profitability on dividend payout in case dividends are smoothed over time, given the reluctance of managers to cut dividends except in extreme and prolonged financial stress (DeAngelo et al. 1992, Brav et al. 2005). In

[36]We further winsorize the capital ratios at the first and the 99th percentile.

[37]To illustrate this argument: $dividends/profit = (profit - retention)/profit = 1 - retention/profits$. Now one can easily see that, if the amount to be retained depends on factors other than current profitability, an increase in profits should lead to a higher dividend payout ratio.

[38]There exists a substantial literature on the role of stock repurchases as a complement to dividends for distributing transitory profits. We do not use net stock repurchases as a control variable in our empirical model. We believe that stock repurchases do not constitute a factor influencing dividend payout but rather are a separate decisions taken simultaneously to the dividend decision.

such a situation, even dividend-smoothing banks may be forced to cancel dividends. In case dividend smoothing is taking place, we would expect the loss dummy to have a negative effect on dividend payout and at the same time higher profitability to lead to a lower adjusted payout ratio.

- **Credit risk**: We expect that higher credit risk ceteris paribus leads to a lower dividend payout. Intuitively, the higher the credit risk, the bigger the necessary capital buffers to prevent a bank closure and the higher the fraction of retained income should be. A credit risk that threatens the future profitability would also induce a dividend smoothing bank to cut dividend payments gradually, starting from the period in which risks are identified. We control for credit risk by including the ratio of loss allowances to loans and leases for the US sample. For the European sample, we use the ratio of loss provisions to loans and leases, as we have data on this item for a larger number of banks.[39] We use again first lags.[40]

- **Other time constant factors**: The dividend policy of banks can in addition be influenced by non-observable or non-measurable bank-specific factors, such as corporate culture, managerial behavior, or clientele effects as in Allen et al. (2000). In particular, if a larger part of the shares of a bank are held by investors with a preference for dividends as opposed to price gains, dividend payout ratios are expected to be higher. Further, life-cycle theories hypothesize that companies, which at the beginning retain profits, start paying dividends once they mature (see e.g. DeAngelo and DeAngelo 2006 and Bulan and Subramanian 2008). We use bank fixed effects to account for bank-specific factors which can be assumed to remain relatively constant over the short sample period of six years.

[39] In terms of accounting, loss provisions are a flow variable, whereas loss allowances are the respective stock variable.

[40] We further winsorize the ratios at the 1st and the 99th percentile.

- **Other time specific factors**: The dividend payout decision further depends on the expected lending opportunities. Banks which expect to face many profitable projects will tend to start retaining a higher fraction of profits to build up a sufficient capital base. Thus, such banks pay out a lower fraction of income to shareholders. The expected business opportunities by individual banks are not observable by outsiders, thus we cannot directly control for them. The most significant factor, however, is the business cycle, for which we include time dummies.

The main aim of our research is to identify whether a shift in the dividend policies of banks has occurred during the crisis. We indeed observe a big increase of dividends paid out relative to net income during the financial crisis. It remains to be investigated how the high dividend payout ratios during the crisis relate to capital, profitability and risk. A shift in banks' payout policy could arise for several reasons.

First, it is possible that institutions on the brink of bankruptcy paid as high as possible dividends at the expense of debtors and deposit insurance companies. If true, we would expect banks with low capital levels, incurring high losses and holding very risky assets, to be the "excessive" dividend payers.

Furthermore, the crisis might have changed the trade-off between the agency costs of free cash flow and the no-flotation-costs benefit of retained earnings.[41] For instance, the perception that past balance sheet data do not fully reflect the risk profiles of individual banks and the observed significant drop in share prices may have made new capital issuance extremely costly. Everything else equal, this should lead to a higher fraction of profits being retained. This effect should be the largest for banks with low capital buffers and high credit risk on their books, as for such institutions the need for additional capital is the highest. Thus, one might expect the positive relation between capital ratios and dividend payout ratios to become more prominent during the crisis period.

[41] The argument is borrowed from the life-cycle theories of corporate dividend policy.

The crisis and the subsequent recession have, however, also led to a decrease in the demand for bank loans.[42] Thus, banks may need less equity to back additional lending, affecting the dividend payout decision of all banks with the same magnitude.

An additional factor is the interplay of competition and financial system stress. The reluctance of bank managers to cancel dividends in times of market turbulence might be an attempt to avoid any doubts about the solvency of the bank. Given the aversion to cut dividends in normal times, it is natural for market participants to associate such an action with severe financial stress.[43]Although empirical evidence suggests that firms use more effective tools to reveal news to the markets, the financial crisis might have damaged the credibility of these channels for the banking industry, rendering dividend policy a more effective supplementary tool.

To identify shifts in dividend payout policy of banks we use:

- **Interaction terms**: We generate interaction terms between the explanatory variables capturing capital, risk and profitability of banks, and a dummy variable equaling one during the crisis and zero otherwise. The coefficients for interaction terms capture the change in the relation between the respective regressor and the adjusted payout ratio during the crisis. We use two different crisis specifications for both the European and the US samples as sensitivity analysis.

- **Control for state recapitalization**: Banks in the United States and in the European Union have had access to government support schemes in the crisis period. To identify shifts in dividend policy related to capital, profitability and risk which are not biased by restrictions related to state recapitalization, we control for participation in it. In the United States, eligible banks could receive funds from the TARP. We include a TARP Dummy which equals one if the Treasury Department holds outstanding preferred shares issued by the bank during the quarter.

[42]For evidence, see e.g. European Central Bank, Euro Area Bank Lending Survey, quarterly available at `http://www.ecb.europa.eu`.

[43]see DeAngelo et al. (2008), p.156.

EU Member States also introduced support schemes for their banking industry or recapitalized individual banks on an ad-hoc basis. To control for such state support we use a State aid Dummy, equaling zero prior to 2008 and one afterwards in case we have found evidence for a state recapitalization and zero otherwise.

Equation 4.2 summarizes our full baseline regression model:

$$r\_div_{it} = \alpha_0 + c_i + c_t + \sum_{j=1}^{4} \beta_j x_{it}^j + \sum_{j=1}^{4} \gamma_j d\_crisis_t x_{it}^j + \sum_{j=1}^{4} \tau_j d\_state_{it} x_{it}^j + d\_state_{it} + \epsilon_{it} \tag{4.2}$$

where r_div_{it} is the adjusted dividend payout ratio, x_{it}^1 - a measure for the capital base, x_{it}^2 captures profitability, x_{it}^3 credit risk, and x_{it}^4 is the loss dummy. d_crisis denotes the crisis dummy variable and d_state is the dummy for state aid. Further, c_i and c_t are time- and bank-specific fixed effects and ϵ_{it} is a standard error term.

In this type of specification, for example the marginal effect of profitability during the pre-crisis period is captured by the coefficient β_2. For the crisis period, the marginal effect is allowed to vary, conditional on whether banks have received state capital or not. For banks which did not receive state capital, the marginal effect of an increase of profitability during the crisis period is measured by the sum of the coefficients β_2 and γ_2. Respectively, for state-recapitalized banks, the marginal effect during the crisis is the sum of β_2, γ_2, and τ_2.

The same logic applies to the other explanatory variables:

$$\begin{aligned} \partial\, r\_div_{it}/\partial\, x^j|_{d\_crisis=0 \text{ and } d\_state=0} &= \beta_j \\ \partial\, r\_div_{it}/\partial\, x^j|_{d\_crisis=1 \text{ and } d\_state=0} &= \beta_j + \gamma_j \\ \partial\, r\_div_{it}/\partial\, x^j|_{d\_crisis=1 \text{ and } d\_state=1} &= \beta_j + \gamma_j + \tau_j \end{aligned} \tag{4.3}$$

The coefficient γ_j reflects how the marginal effect of an increase of the respective x_j has changed in the crisis period compared to the pre-crisis period for non-state-recapitalized banks. The τ_j coefficients measure any differences in the marginal effects during the crisis period between banks that have been recapitalized with state aid and their competitors that have not.

Throughout all specifications and samples used, the inference is based on cluster-standard errors that account for conditional heteroskedasticity between bank clusters and serial correlation of the residuals ϵ_{it} within bank clusters. We report the respective p-values in parentheses.

4.7 Dividends in the United States

We start by analyzing the US data. Before we present the regression results, we provide an overview of how the adjusted ratio of dividends to net income evolved over time between 2003-2009 in Figure 4.6. The Figure distinguishes between the group of banks which used TARP for at least one quarter and those which did not use TARP at all. In Figure 4.7 we divide the sample along profitability. Especially striking is the observation that the banks which were supported by the US Department of the Treasury in the aftermath of Lehman Brother's default had paid on average higher fractions of profits to shareholders prior to receiving state support than their peers . The difference is the biggest for the two quarters around the default of Lehman Brothers. As some of the institutions exited TARP in the third quarter of 2009, the average dividend payout ratio for this group of banks became higher again.

We start the econometric analysis by splitting the sample into a pre-crisis period that ends in the second quarter of 2007 and into a crisis period which starts right after, in the third quarter of 2007.

We run regressions of the adjusted dividend payout ratios on our measures for capital, profitability, risk and control variables for both periods separately. For the crisis period, we additionally control for the participation of banks in TARP and include interaction terms between the TARP dummy and the main explanatory variables. TARP restricts the dividend payout decisions of participating banks to both common and preferred shareholders. Including the interaction terms with the TARP dummy allows us to differentiate between the dividend payout decisions of non-participating banks and

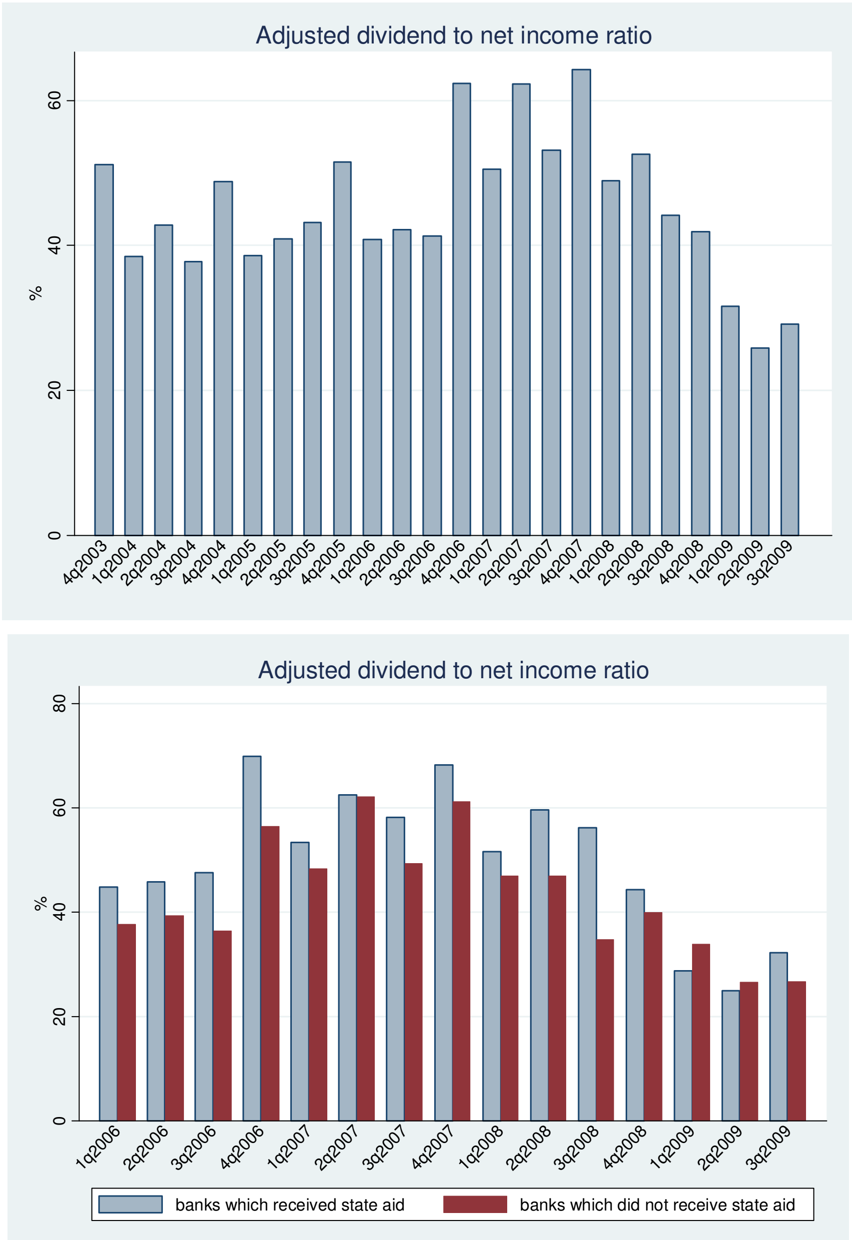


Figure 4.6: Mean of the adjusted dividend payout ratio in the United States

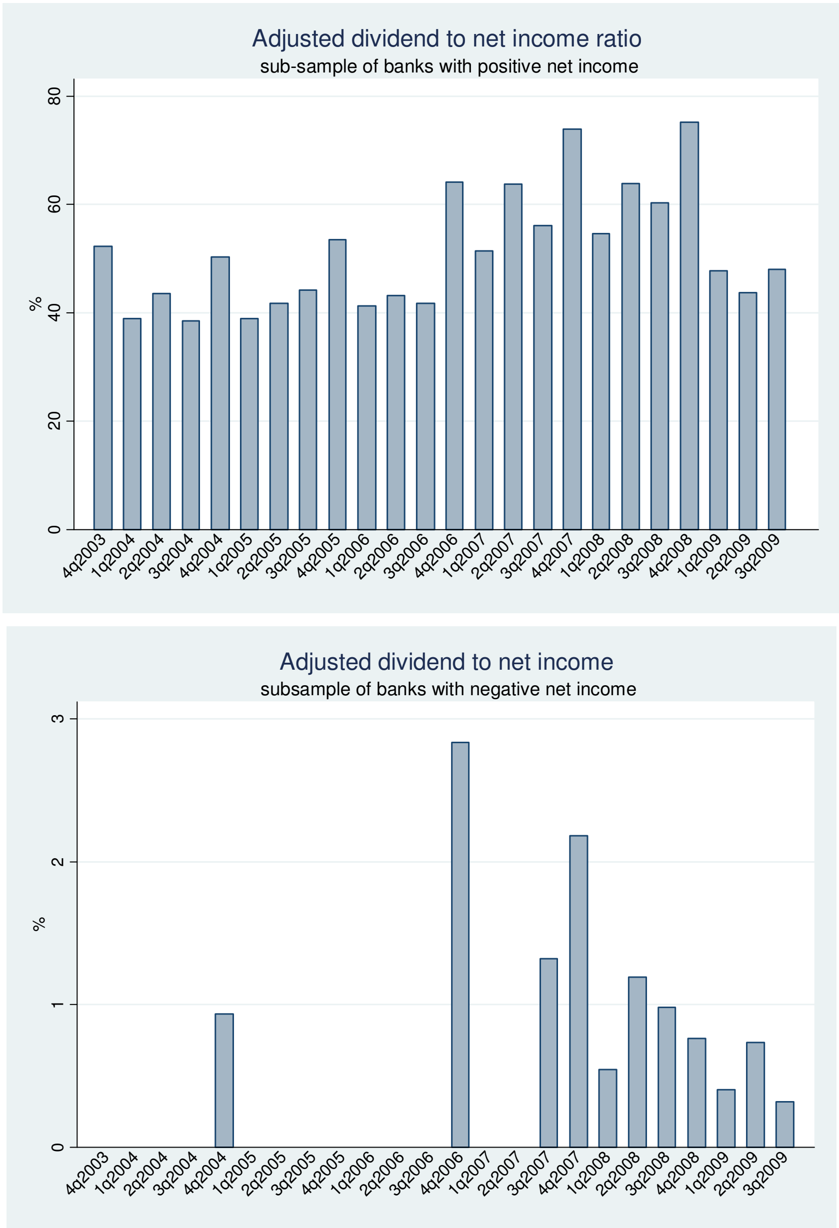


Figure 4.7: Mean of the adjusted dividend payout ratio in the United States

the restricted choices for banks which received state aid.

Let us very briefly summarize the most important features of the program.[44]

- **Form**: Capital is made available in the form of senior preferred shares which count as Tier 1 regulatory capital. They are not part of the balance sheet equity of banks. The shares have no voting rights.
- **Amount**: The minimum subscription amount per institution is 1% of its risk-weighted assets. The maximum amount is either USD 25 billion or 3% of risk-weighted assets.
- **Remuneration**: The shares pay a 5% cumulative dividend rate for the first five years, and 9% for the consecutive years.
- **Restrictions**: Executive compensation for participating banks is considerably restricted. With regard to dividend payments to shareholders other than the Department of the Treasury, the restrictions are rather mild: As long as the TARP senior preferred shares are outstanding, dividend payments on either junior preferred shares, preferred shares pari passu to the TARP shares or common shares can be made only after dividends to the Department of Treasury have been fully paid. To increase dividends to common shareholders, banks need an explicit permission by the Department of Treasury.

We perform a fixed-effects within estimation and report the results for the *pre-crisis* sub-sample in Table 4.1.

In a first step we individually include the explanatory variables and control for time effects via a set of quarter dummies. The upper panel of Table 4.1 shows that only capital, profitability and the loss dummy are significant when included individually.

As expected, higher capital, as measured either with the lagged ratio of capital to risk-weighted assets or with the lagged ratio of equity to total

[44]See United States Department of Treasury (2008), TARP Capital Purchase Program, Senior Preferred Stock and Warrants, Summary of Senior Preferred Terms, available at `http://www.ustreas.gov/press/releases/reports/document5hp1207.pdf`

assets, tends to coincide with a higher adjusted dividend payout ratio; see Columns (1) and (2). The relation becomes stronger when we include our measure for credit risk. The coefficients for both capital ratios remain significant at the 1% level; see Columns (7) and (8). The lagged level of loss allowances to loans has the expected negative sign but is not significant.

Furthermore, the higher the return on assets, the lower the payout ratio seams to be; see Column (3). As expected, banks which incur losses cancel dividends; see Column (4). Including both variables at the same time in Column (9) leads to a more strongly significant estimate for the coefficient for return on assets. This supports the hypothesis that banks smooth their dividend payments over time whenever possible and cut them to significantly lower levels only in the case of a marked drop in profitability. Additionally including the log of total assets does not change the coefficients.[45]

Our baseline results for the pre-crisis period are reported in Column (11) using the lagged ratio of capital to risk-weighted assets, and in Column (12) using the lag of equity to total assets. The coefficients reflecting the relation between the dividend payout ratio and the measures for capital, profitability and losses are all significant at the 1% level. Banks with higher capital buffers tend to pay out a higher fraction of net income to shareholders and banks which incur losses tend to cancel dividends altogether. The negative coefficient of the return on assets implies that banks smooth dividends over time and adjust their levels only if shocks to profitability are considered permanent. Credit risk seems not to influence the payouts significantly during this period.

Table 4.2 summarizes the results for the period during the crisis, using the lagged ratio of capital to risk-weighted assets.[46] We again first include the explanatory variables individually using only the TARP Dummy and a

[45]Larger banks are often more leveraged than small banks, see for instance Gropp and Heider (2009). Whenever we do not control for the amount of capital, the log of total assets acts as a proxy and captures that bigger banks hold less capital relative to the size of their balance sheet, which tends to lead to a lower adjusted dividend payout ratio as already reported.

[46]Results using the alternative measure Equity to Total Assets can be found in Table 4.15 in Appendix C. The results are similar both qualitatively and quantitatively.

Table 4.1: Fixed-effects estimation results for the pre-crisis period, US sample

Pre-Crisis Period

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Capital/RWA)	0.360***					
	(0.00)					
L1.(Equity/Total Assets)		1.062***				
		(0.00)				
Return on Assets			-2.853*			
			(0.07)			
Loss Dummy				-30.85***		
				(0.00)		
L1.(Loss Allowances/Loans)					-0.693	
					(0.35)	
Log of Total Assets						-2.086
						(0.26)
Observations	7433	7433	7435	7435	7366	7435
Number of bank clusters	505	505	505	505	502	505
R-squared	0.020	0.022	0.019	0.023	0.019	0.019
F test p-value	0	0	7.50e-11	0	2.84e-10	1.01e-10
Bank fixed effects	yes	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(7)	(8)	(9)	(10)	(11)	(12)
L1.(Capital/RWA)	0.604***				0.666***	
	(0.01)				*(0.00)*	
L1.(Equity/Total Assets)		1.253***				1.323***
		(0.00)				*(0.00)*
Return on Assets			-6.742***	-6.795***	-6.467***	-6.579***
			(0.00)	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy			-44.57***	-46.00***	-48.05***	-47.20***
			(0.00)	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-0.789	-0.883			-0.319	-0.408
	(0.33)	*(0.33)*			*(0.66)*	*(0.61)*
Log of Total Assets				-4.233**	-0.643	-0.0852
				(0.04)	*(0.83)*	*(0.98)*
Observations	7366	7366	7435	7435	7364	7364
Number of bank clusters	502	502	505	505	502	502
R-squared	0.021	0.022	0.027	0.027	0.029	0.030
F test p-value	1.01e-10	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

set of quarter dummies as control variables. The estimates are presented in the upper panel of Table 4.2. The most notable difference to the pre-crisis sample is that risk now seems to influence the payout decision in the crisis period; see Column (4).

The lower panel of Table 4.2 reports the baseline regression for the crisis period.[47] We augment it step by step by including the TARP Dummy and the TARP interaction terms. Throughout all specifications, the coefficients reflecting the relation between the dividend payout ratio and the measures for profitability, risk and the Loss Dummy are significant at the 1% level, and the coefficient for capital at the 5% level.

Let us first focus on how the dividend payout policy of banks which received state aid differ from those of banks which did not in the crisis period. The difference is captured by the TARP Dummy and TARP interaction effects.

In Column (6) we fist include a single TARP interaction term with the lagged capital ratio. Results suggest that banks with outstanding TARP shares ceteris paribus paid a lower fraction of profits to share holders, as suggested by the significantly negative coefficient for the TARP Dummy. Furthermore, whereas an increase of the capital ratio of 1 percentage point leads to an around 2 percentage points higher fraction of profits paid out for non-TARP-supported banks, the relation is stronger for TARP-supported banks: the total effect of a 1 percentage point increase is 2 + 4,4 percentage points. The result could be driven by the fact that a higher capital ratio for TARP-supported banks could mean a higher state stake in the institution. According to the conditions of TARP, the state-owned preferred shares have to be remunerated with a dividend rate of 5%, a number not significantly different from to the coefficient for the interaction term.[48]

In Column (7) we include a TARP interaction term with the profitability measure. The TARP Dummy is no longer significant, although its sign

[47]The regression is similar to the one presented in Column (11) in Table 4.1 for the pre-crisis period.

[48]An F-test performed after the regression could not reject the null hypothesis that the coefficient for the interaction term between TARP and the capital ratio is equal to five.

Table 4.2: Fixed-effects estimation results for the crisis period, US sample

Crisis Period

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Capital/RWA)	2.700***				
	(0.01)				
Return on Assets		2.968***			
		(0.00)			
Loss Dummy			-60.95***		
			(0.00)		
L1.(Loss Allowances/Loans)				-11.04***	
				(0.00)	
Log of Total Assets					13.17
					(0.26)
TARP Dummy	-12.04**	-8.084	-3.108	-7.037	-9.315*
	(0.02)	*(0.11)*	*(0.51)*	*(0.17)*	*(0.07)*
Observations	4413	4417	4418	4396	4417
Number of bank clusters	506	506	506	503	506
R-squared	0.037	0.042	0.105	0.040	0.032
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(6)	(7)	(8)	(9)	(10)
L1.(Capital/RWA)	2.061**	2.367**	2.371**	2.358**	2.024**
	(0.03)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.03)*
Return on Assets	-1.236***	-2.006***	-1.303***	-1.239***	-1.841***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy	-62.80***	-63.27***	-61.45***	-62.44***	-64.16***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-7.648***	-7.622***	-7.156***	-5.399***	-5.740***
	(0.00)	*(0.00)*	*(0.00)*	*(0.01)*	*(0.00)*
Log of Total Assets	4.215	5.295	5.709	5.890	3.774
	(0.69)	*(0.62)*	*(0.59)*	*(0.58)*	*(0.72)*
TARP Dummy	-59.91***	-2.617	-2.260	5.462	-50.07***
	(0.00)	*(0.58)*	*(0.72)*	*(0.45)*	*(0.01)*
TARP*L1.(Capital/RWA)	4.360***				4.572***
	(0.00)				*(0.00)*
TARP*Return on Assets		1.907***			1.802***
		(0.00)			*(0.01)*
TARP*Loss Dummy			-5.643		6.055
			(0.43)		*(0.44)*
TARP*L1.(Loss Allowances/Loans)				-5.052**	-6.590***
				(0.04)	*(0.00)*
Observations	4387	4387	4387	4387	4387
Number of bank clusters	503	503	503	503	503
R-squared	0.118	0.114	0.114	0.114	0.121
F test	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

remains negative. With regard to the effect of profitability on the payout ratio, our estimation suggests that non-TARP-funded banks have continued smoothing dividends, reflected in a significantly negative coefficient for the return on assets. Banks supported by government aid, in contrast, did not seem to smooth dividends. The effect of profitability on the adjusted dividend payout ratio, captured by the sum of the coefficients for profitability and its interaction term with the TARP Dummy, was minimal and not significantly different from zero; see the Column (7).[49]

We then continue the analysis by including a TARP interaction term with the loss dummy and with the lagged ratio of loss allowances to loans and leases in the next two columns. We do not find any significantly different effect of the loss dummy on the payout ratio for both groups of banks. Credit risk, however, seems to have affected the payout decision of TARP banks twice as strongly, with an elasticity of -10,5 as opposed to -5.4.

We include all TARP interaction terms in our baseline regression for the crisis period in Column (10). The results remain the same as in the individual inclusion described above.

To summarize the results of the sample-split exercise, let us highlight the most significant differences in our results for the two periods by comparing the baseline models , i.e. Column (11) in Table 4.1 and Column (10) in Table 4.2. Whereas credit risk seems not to have affected the dividend decisions of banks significantly in the pre-crisis period, banks with higher credit risk seem to have paid out a lower fraction of profits to shareholders during the crisis. The results furthermore indicate that dividend smoothing has been stronger in the pre-crisis period, reflected in a more than three times higher coefficient for the return on assets. Banks supported by TARP seem to have stopped smoothing altogether. Finally, the positive relation between capital and dividend payout ratio appears to be stronger during the crisis. All these observations do not suggest imprudent behavior of banks during the crisis.

Interesting is the observed difference in the payout decision of state-supported banks and banks which did not obtain capital from TARP: The

[49] An F-test performed after the regression could not reject the hypothesis that the sum of the coefficients is equal to zero.

former seem to have behaved in a more prudent or cautious way. One may attribute this observation to effective restrictions on dividend payments. Part of the observed difference, though, could have arisen for other reasons. For instance, it is possible that dividend payouts as a means to maintain an image of stability and to prevent adverse market reactions lost relevance with the acceptance of state support. Seeking state support has already revealed the fragility of the bank in question. Banks which did not participate in TARP could in contrast have used their dividend policy to signal stability to markets. Thereby they might have adjusted their dividends more slowly and gradually to the significantly lower profitability in the crisis period.

Next, we use the full sample and include interaction terms to identify significant shifts in corporate payout policy. We proceed in two steps. First, we include "Crisis" interaction terms that capture possible systematic shifts in the relation between the dividend payout ratios and bank characteristics. Similarly to the above sample-split exercise we define as crisis the period starting after the second quarter of 2007. To make sure results are not sensitive to the minor changes in the definition, we also use alternative "Crisis2" interaction terms, for which the crisis period is assumed to start and to end a period earlier, i.e. the second quarter of 2007 now belongs to the crisis period, and the third quarter of 2009 is not labeled as a crisis period any more. Second, we include "Lehman" interaction terms to capture possible reactions of the institutions in the sample to the unexpected shock of the Lehman Brothers default in the last quarter of 2008.[50] This is the period in which the state recapitalization program TARP was introduced.

Table 4.3 shows the estimates for the baseline crisis interaction terms and Table 4.4 for the alternative, crisis2, terms.[51] Similarly to our approach before, we include TARP and crisis interaction terms step by step.

Overall, the results are very similar to what the sample split revealed. We are not able to find evidence of a significant shift in the relation between bank

[50]The actual bankruptcy of Lehman Brothers took place on 15 September 2008 at the end of the third quarter of 2008. We took the subsequent quarter because the full magnitude of the systemic crisis had not yet been materialized for the third quarter.

[51]The results using the lagged ratio of equity to total assets are presented in Tables 4.18 and 4.22 in Appendix C.

characteristics and the dividend payout ratios for banks not participating in TARP. The interaction term of the crisis dummy with the lagged capital to risk-weighted assets is significant at the 10% level only when all other interaction terms are included; see Column (11). The significance disappears in the alternative specifications that use the crisis2 dummy or the ratio of equity to total assets; see Table 4.4, and Tables 4.18 and 4.22 in Appendix C. The coefficient for the loss dummy turns out to be the only robustly significant coefficient for a crisis interaction term. The result suggests that banks which incurred losses have reduced dividends more aggressively during the crisis than during the pre-crisis period. We believe, however, that some caution is appropriate in this regard. Losses were common during the crisis, but hardly ever observed in the pre-crisis period, and this might drive the results.

In contrast, banks which were supported by the US Department of Treasury pursued a significantly different payout policy. The TARP interaction terms with the return on assets and the ratio of loss allowance to loans and leases are significant and point to a shift away from dividend smoothing and towards taking the amount of credit risk in the bank's loan book more strongly into account when dividend decisions were made.

The evidence for a significant change in the relation between the strength of the capital base and the adjusted dividend payout ratio for TARP supported banks is rather unconvincing. As already remarked in the sample-split exercise, the positive coefficient of the interaction term between the TARP dummy and capital to risk-weighted assets might reflect the fact that participating banks are required to pay dividends to the Department of Treasury that amount to 5% of the injected capital. Thus, if capital to risk-weighted assets increases for those banks due to a higher stake of the government, payouts reflect a higher contractual obligation to pay preferred dividends to the US Department of the Treasury. Because the injected preferred capital is not part of equity in accounting terms, variations in the ratio of equity to total assets are not driven by the stake of the US government. Using the ratio of equity to total assets to measure the strength of the bank's capital base, the interaction term with the TARP dummy becomes insignificant both for the

Table 4.3: Fixed-effects estimation results including crisis interaction terms, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Capital/RWA)	0.682***	0.668***	0.628**	0.656***	0.622***
	(0.00)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.00)*
Return on Assets	-1.403***	-2.966**	-1.555***	-1.498***	-2.134
	(0.00)	*(0.02)*	*(0.00)*	*(0.00)*	*(0.13)*
Loss Dummy	-53.55***	-54.28***	-39.04***	-53.68***	-40.13***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.771*	-1.917*	-1.867**	-1.205*	-0.991
	(0.08)	*(0.06)*	*(0.05)*	*(0.08)*	*(0.13)*
Log of Total Assets	2.661	2.726	3.211	2.811	2.701
	(0.33)	*(0.33)*	*(0.24)*	*(0.31)*	*(0.33)*
TARP Dummy	-47.93**	-3.312	-2.648	6.998	-39.08**
	(0.01)	*(0.42)*	*(0.64)*	*(0.28)*	*(0.02)*
TARP*L1.(Capital/RWA)	3.379**				3.713**
	(0.03)				*(0.01)*
Crisis*L1.(Capital/RWA)	0.519				0.589*
	(0.11)				*(0.08)*
TARP*Return on Assets		1.449***			1.620***
		(0.01)			*(0.00)*
Crisis*Return on Assets		1.224			0.0274
		(0.32)			*(0.98)*
TARP*Loss Dummy			-4.903		7.222
			(0.42)		*(0.28)*
Crisis*Loss Dummy			-16.97***		-17.51***
			(0.00)		*(0.00)*
TARP*L1.(Loss Allowances/Loans)				-5.811***	-6.990***
				(0.00)	*(0.00)*
Crisis*L1.(Loss Allowances/Loans)				-0.439	-0.950
				(0.56)	*(0.27)*
Observations	11756	11756	11756	11756	11756
Number of bank clusters	503	503	503	503	503
R-squared	0.065	0.063	0.063	0.064	0.067
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.4: Fixed-effects estimation results: Sensitivity analysis using alternative crisis interaction terms, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Capital/RWA)	0.669***	0.673***	0.646***	0.661***	0.628***
	(0.00)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*
Return on Assets	-1.397***	-2.507***	-1.518***	-1.459***	-1.847**
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.03)*
Loss Dummy	-53.77***	-54.40***	-42.66***	-53.68***	-42.75***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.843*	-1.961*	-1.947**	-1.311*	-1.350*
	(0.07)	*(0.06)*	*(0.05)*	*(0.08)*	*(0.10)*
Log of Total Assets	2.572	2.824	3.218	2.806	2.633
	(0.35)	*(0.31)*	*(0.24)*	*(0.31)*	*(0.34)*
TARP Dummy	-50.97***	-3.244	-1.792	7.830	-41.28**
	(0.01)	*(0.43)*	*(0.75)*	*(0.23)*	*(0.02)*
TARP*L1.(Capital/RWA)	3.620**				4.066***
	(0.02)				*(0.01)*
Crisis2*L1.(Capital/RWA)	0.278				0.291
	(0.48)				*(0.48)*
TARP*Return on Assets		1.619***			1.505***
		(0.00)			*(0.01)*
Crisis2*Return on Assets		0.765			-0.162
		(0.32)			*(0.84)*
TARP*Loss Dummy			-7.656		4.548
			(0.20)		*(0.49)*
Crisis2*Loss Dummy			-13.89***		-16.24***
			(0.00)		*(0.00)*
TARP*L1.(Loss Allowances/Loans)				-6.217***	-7.777***
				(0.00)	*(0.00)*
Crisis2*L1.(Loss Allowances/Loans)				0.187	0.108
				(0.80)	*(0.90)*
Observations	11756	11756	11756	11756	11756
Number of bank clusters	503	503	503	503	503
R-squared	0.065	0.063	0.064	0.064	0.067
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

baseline Crisis Dummy and for Crisis2; see Tables 4.18 and 4.22 in Appendix C.

The outcomes using the Lehman interaction terms are very similar; see Table 4.5 and Table 4.19 in Appendix C. The results differ form the previous ones only with regard to the interaction term between the Lehman dummy and return on assets. The estimate suggest that during the fourth quarter of 2008 dividends were smoothed to a lesser extent by all banks, with TARP-funded banks not smoothing at all. The marginal effect of a 1% increase in profitability for non-TARP banks is still negative for the fourth quarter of 2008, equaling -1.81, but less strong compared to the average effect of -2.548 for other quarters. For banks supported by TARP, the marginal effect is not significantly different from zero. [52]

Overall, our results suggest that no significant policy shift has taken place during the crisis period for US banks which were not supported by TARP. Dividend levels seem to have been adjusted rather slowly and gradually to the sharp profitability shock, and we found no evidence that the relation between the strength of the capital base of banks and dividend payout ratios was more prominent during the crisis period compared to historical standards. Bank which needed state aid, though, significantly decreased smoothing of dividends and and increased the sensitivity of payouts to credit risk in their loan book.

Two remarks of the results can be made. On the one hand, one can argue that the findings support the view that weaker banks, i.e. those which needed state aid, have taken measures to preserve their capital base. Banks that were healthy enough to survive without government support did not significantly adjust their behavior which could be considered unproblematic, given their relative strength.

On the other hand, government support to a group of ailing banks entails significant positive externalities to the perceived stability the banking system. To put it in a nutshell, even banks which did not receive state funds

[52]We performed an F-test with the null hypothesis that the sum of the coefficients in front of return on assets, Lehman*return on assets and TARP*return on assets is zero. The null hypothesis could not be rejected.

Table 4.5: Fixed-effects estimation results including Lehman interaction terms, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Capital/RWA)	0.651***	0.675***	0.665***	0.659***	0.633***
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*
Return on Assets	-1.397***	-2.784***	-1.714***	-1.492***	-2.548***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy	-53.90***	-55.70***	-49.99***	-53.70***	-52.99***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.918*	-2.063*	-1.963*	-1.267*	-1.437*
	(0.06)	*(0.06)*	*(0.06)*	*(0.08)*	*(0.08)*
Log of Total Assets	2.434	2.788	3.026	2.826	2.191
	(0.38)	*(0.32)*	*(0.27)*	*(0.31)*	*(0.44)*
TARP Dummy	-51.96***	-3.207	-2.392	7.267	-42.37**
	(0.01)	*(0.44)*	*(0.68)*	*(0.26)*	*(0.02)*
TARP*L1.(Capital/RWA)	3.697**				4.164***
	(0.02)				*(0.01)*
Lehman*L1.(Capital/RWA)	-0.150				-0.344
	(0.72)				*(0.42)*
TARP*Return on Assets		1.384**			1.261**
		(0.01)			*(0.03)*
Lehman*Return on Assets		2.653***			1.467***
		(0.00)			*(0.01)*
TARP*Loss Dummy			-5.611		6.071
			(0.36)		*(0.36)*
Lehman*Loss Dummy			-28.42***		-23.17***
			(0.00)		*(0.00)*
TARP*L1.(Loss Allowances/Loans)				-5.954***	-8.116***
				(0.00)	*(0.00)*
Lehman*L1.(Loss Allowances/Loans)				-1.538	0.408
				(0.45)	*(0.84)*
Observations	11756	11756	11756	11756	11756
Number of bank clusters	503	503	503	503	503
R-squared	0.065	0.064	0.065	0.064	0.068
F test	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

indirectly benefited from state recapitalization, as the banking system as a whole became more stable. Thus, the strength of non-TARP-supported banks hinges on the participation decision of their competitors.

4.8 Dividends in the European Union

We now turn our attention to the European sample. The data quality and frequency considerably restricts our analysis: Out of the 287 banks for which we have information on dividends, we have data on the measures for profitability, risk, and capital for 221 banks for on average 2.8 years. Furthermore, out of those 221, we have data on all variables for 2008 for only 131 banks.

Given that we are interested in identifying shifts in the dividend policy during the crisis and contrasting it to the payout in the pre-crisis period, information on bank characteristics and payouts during the crisis is essential. Thus, for our baseline analysis we use the sample of the 131 banks. For these banks, data is available for on average 3.1 years. We repeat all estimations in a second step using the broader sample of 221 banks and call it the "full sample". This allows us to check whether the results are sensitive to sampling.[53]

Because of the limited availability of data we abstract from a split in a pre-crisis and crisis period and instead include crisis interaction terms from the beginning on. Similarly to our proceeding for the US data, we use two definitions of the crisis period: we first use a crisis dummy equaling 1 in the year 2008, and second, a crisis2 dummy which takes the value of 1 in 2007 and 2008. The results using crisis2 are reported in Tables 4.26 and 4.27 in Appendix C.

We start our analysis using the baseline sample. We first perform a fixed effects regression of the adjusted dividend payout ratio on the lagged ratio of equity to total assets, the return on assets, the lagged ratio of loss provisions to loans, the log of total assets, the state aid dummy and a set of year

[53]Even in this broader sample we can use at most the data on the 131 banks to identify the dividend decisions of banks during the crisis period. This is different is for the estimates for the dividend payout during the pre-crisis period.

dummies.[54] We then include state aid and crisis interaction terms step by step. The results are reported in Table 4.6.

Column (1) shows the estimates prior to the inclusion of interaction effects. The coefficient for the capital ratio has a counterintuitive negative sign, is insignificant and stays negative and insignificant throughout all specifications.[55] The coefficient for return on assets is negative and significant, indicating, similarly to the results for the United States, that banks tend to smooth dividend payments. Banks experiencing losses tend to cut dividends altogether, as implied by the negative and significant sign for the loss dummy. None of the coefficients for the lagged loss provisions to loans, the log of total assets or the state aid dummy are significant.

In Columns (2) to (5) we sequentially include the state aid and crisis interaction terms. We start by adding interactions with the lagged ratio of equity to total assets. The interaction with the state aid dummy is significantly negative, counter to what common sense suggests. The result implies that, for banks supported with government capital, lower equity ratios tend to coincide with high dividend ratios. The counter-intuitive result possibly arises as a consequence of a timing mismatch in the data. We have no information on the exact dates of dividend payments and government recapitalizations. Most of the direct government recapitalizations took place at the beginning of 2009. Similarly, many banks paid dividends for 2008 at the beginning of 2009.[56] Thus, we cannot rule out that the sequence of events is rather that banks which had low capital buffers and had paid high dividends relative to their earnings were particularly fragile, and thus had to approach the national authorities for state aid schemes.

Next, we include interaction terms with profitability and report results in Column (3). The coefficient for the crisis interaction term is negative and significant at the 5% level. Banks have seemingly smoothed dividends even

[54]Results from univariate regressions similar to those performed for the US sample are shown in Table 4.23 in Appendix C

[55]Using the full sample instead of the baseline, the coefficient for the lagged capital ratio has a positive sign but is again not significant throughout all specifications.

[56]For instance, Deutsche Bank pays it dividends regarding a fiscal year in the middle of May of the following year.

Table 4.6: Fixed-effects estimation results including crisis interaction terms, EU baseline sample

Baseline Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	-0.363	-1.318	-1.134	-0.366	-0.314	-2.349
	(0.88)	*(0.55)*	*(0.63)*	*(0.88)*	*(0.89)*	*(0.32)*
Return on Assets	-12.89**	-11.60**	-15.75***	-13.03**	-12.71***	-14.19***
	(0.02)	*(0.04)*	*(0.00)*	*(0.02)*	*(0.00)*	*(0.01)*
Loss Dummy	-95.64***	-106.9***	-116.3***	-51.71***	-101.0***	-53.49***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Provisions/Loans)	1.501	1.472	1.842	1.627	6.266**	5.685*
	(0.57)	*(0.56)*	*(0.51)*	*(0.53)*	*(0.03)*	*(0.06)*
Log of Total Assets	-9.746	-11.51	-13.25	-11.07	-11.37	-18.27
	(0.57)	*(0.51)*	*(0.42)*	*(0.53)*	*(0.48)*	*(0.25)*
State Aid Dummy	9.087	60.24	5.646	8.445	-10.17	51.23
	(0.60)	*(0.11)*	*(0.76)*	*(0.68)*	*(0.71)*	*(0.36)*
State Aid*L1.(Equity/Total Assets)		-6.586**				-8.035**
		(0.04)				*(0.04)*
Crisis*L1.(Equity/Total Assets)		0.659				1.118
		(0.54)				*(0.23)*
State Aid*Return on Assets			-2.875			-2.534
			(0.73)			(0.84)
Crisis*Return on Assets			-8.682**			-7.881**
			(0.03)			*(0.04)*
State Aid*Loss Dummy				8.499		-24.94
				(0.77)		*(0.63)*
Crisis*Loss Dummy				-52.60**		-72.23***
				(0.05)		*(0.01)*
State Aid*L1.(Provisions/Loans)					44.89	63.48
					(0.53)	*(0.28)*
Crisis*L1.(Provisions/Loans)					-48.94***	-41.69**
					(0.00)	*(0.02)*
Observations	407	407	407	407	407	407
Number of bank clusters	131	131	131	131	131	131
R-squared	0.158	0.181	0.180	0.161	0.201	0.248
F test p-value	1.24e-06	1.17e-05	8.53e-07	.	1.84e-08	.
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

stronger during 2008. The magnitude of the marginal effect of profitability on the payout ratio is at fist sight implausible. According to the estimated marginal effect, a drop in profitability of one percentage point leads to an increase in the payout ratio by 23 percentage points in 2008.[57] Such an outcome would imply that whenever profitability drops, the level of dividends paid is actually strongly increased by the bank management. At a second look, the outcome seems to need further qualifying. A drop of the return on assets of one percentage point implies for the average bank in sample that it has incurred a loss during the quarter. Thus, we cannot consider the loss dummy to stay constant and equal to zero. Such a profitability drop is generally not considered transitory and is no longer smoothed. The overall effect on the payout ratio of this type of profitability shock is negative and leads on average to a reduction of dividend payments.

Subsequently, we include interaction terms with the loss dummy. Similarly to the results for the US sample, the significantly negative coefficient for the interaction term implies that banks which incurred losses during 2008 tended to cancel dividend payments even more often than during the pre-crisis period.[58]

Finally, we include interaction terms with our measure for credit risk - loss provisions to loans. Once a crisis interaction term is included, the coefficient for the lagged value of provisions to loans increases and becomes significantly positive. The coefficient for its crisis interaction is negative and significant at the 1% level. The result indicates a shift in the relation between credit risk and dividend payout. During 2008, banks which had to increase their allowances for losses in the face of higher delinquencies tended to also retain a higher fraction of profits to build up their capital base, as implied by the negative sum of the coefficients for provisions to loans and its crisis interaction term. Prior to 2008, the relation was rather the opposite.

None of the described results change when all the interaction terms are

[57] Calculated as the sum of the coefficient for return on assets and its interaction term with the crisis dummy.

[58] We do not over-emphasize this particular result, as losses are hardly observed prior to 2008 and this may influence results.

included simultaneously; see Column (6). With the exception of the interaction term with equity to total assets, the state aid dummy and state aid interaction terms remain insignificant throughout all specifications in Table 4.6. Table 4.7 shows that the results do not change when all regressions are performed using the baseline sample without state aid interaction terms. In a similar vein, the majority of estimates remain unchanged in estimations using the full sample; see Tables 4.24 and 4.25 in Appendix C. Two minor differences appear, however. First the coefficient for the lagged ratio of equity to total assets becomes positive, which is the expected sign, but remains insignificant. Second, the significance of the coefficient for provisions to loans improves. We interpret this as evidence that our results are not sensitive to minor changes in the composition of the EU sample.

As a last step, we use interaction terms with the crisis2 dummy for both the baseline and the full sample, in order to check whether our results are sensitive to changes in the definition of the crisis period.[59] And indeed they are. Using the baseline sample, the crisis2 interaction terms with profitability and the credit risk measure are no longer significant. The outcome is not particularly surprising, as the big drop in profitability and the surge in provisioning expenses occurred in 2008. Furthermore, because the state aid dummy takes values of one only in 2008, it is possible that it acts as a proxy for the replaced crisis dummy.[60]

To summarize our findings for the European sample, we first found some evidence for stronger dividend smoothing during 2008. Second, banks which experienced material deteriorations of profitability tended to cancel dividend payments altogether more often than in the pre-crisis period. Furthermore, banks with higher credit risk in their loan books seem to have paid a higher fraction of net income to shareholders up to 2008. In 2008, however, the dividend payout policy of these banks has significantly shifted towards retaining a higher fraction of profits whenever credit risk increases.

[59] The results are reported in Tables 4.26 and 4.27 in Appendix C.

[60] Note that our dataset provides us with observations for three periods per bank on average. The variation in the definition of crisis from 2008 only to both 2007 and 2008 is substantial. Therefore, the sensitivity of our results to the variation is by far not excessive.

Table 4.7: Fixed-effects estimation results: Sensitivity analysis excluding state aid interaction terms, EU baseline sample

Baseline Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	-0.363	-0.283	-1.169	-0.358	-0.161	-0.861
	(0.88)	*(0.90)*	*(0.61)*	*(0.88)*	*(0.94)*	*(0.72)*
Return on Assets	-12.89**	-13.16**	-16.27***	-13.09**	-12.41***	-15.38***
	(0.02)	*(0.02)*	*(0.00)*	*(0.02)*	*(0.00)*	*(0.00)*
Loss Dummy	-95.64***	-96.86***	-115.1***	-51.77***	-103.2***	-54.21***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Provisions/Loans)	1.501	1.536	1.913	1.622	6.363**	6.217*
	(0.57)	*(0.55)*	*(0.49)*	*(0.53)*	*(0.03)*	*(0.05)*
Log of Total Assets	-9.746	-9.397	-13.23	-11.05	-12.55	-17.00
	(0.57)	*(0.58)*	*(0.42)*	*(0.53)*	*(0.45)*	*(0.30)*
State Aid Dummy	9.087	9.206	4.765	9.992	2.345	1.010
	(0.60)	*(0.60)*	*(0.78)*	*(0.57)*	*(0.89)*	*(0.95)*
Crisis*L1.(Equity/Total Assets)		-0.262				0.103
		(0.86)				*(0.94)*
Crisis*Return on Assets			-9.088**			-7.308**
			(0.01)			*(0.02)*
Crisis*Loss Dummy				-48.48**		-69.78***
				(0.03)		*(0.00)*
Crisis*L1.(Provisions/Loans)					-44.79***	-38.91**
					(0.01)	*(0.03)*
Observations	407	407	407	407	407	407
Number of bank clusters	131	131	131	131	131	131
R-squared	0.158	0.158	0.180	0.160	0.197	0.214
F test p-value	1.24e-06	2.06e-06	3.10e-07	.	7.94e-08	.
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Compared to the results for the United States, three major differences emerge. First and most prominently, the participation in TARP seems to relate to a more prudent dividend payout policy in the United States. Banks participating in TARP have tended to stop dividend smoothing and to pay out lower fractions of profits as credit risk have increased. We do not observe such a relation in the European sample. State support schemes do not seem to have played a role for dividend payouts. Second, we are not able to find a systematic shift in the relation between bank characteristics and dividend ratios for non-TARP participating banks in the United States. As stated above, we find some evidence for stronger smoothing and a stronger effect of increased credit risk on dividend payout in the European Union. Finally, capital ratios seem to not to have influenced the fraction of profits retained in the European Union. Not in a single specification in our analysis is the coefficient for equity to total assets significantly positive, and in some it is even negative.

4.9 Conclusion

The surge in dividend payments relative to net profits in the United States during the period of 2007 - 2008 and in the European Union in 2008 seems ominous at first sight. Taking into account how dividend payout ratios relate to profitability, credit risk and the capital base of banks, the picture does not look as alarming any more. For US banks participating in TARP, we observe a significant shift of dividend policies towards higher sensitivity to credit risk and lesser smoothing over time. US banks that have not received support have, in contrast, not significantly adjusted their dividend policies: for these banks, dividends seem to have declined only gradually in the aftermath of the profitability shock. Similarly to the results on the US banks receiving state support, European banks seem to have increased the influence of credit risk considerations on dividend decisions. However, we also find some evidence for stronger dividend smoothing during the crisis period compared to the period up to 2008.

In sum, most of the observed surge in payout-profit ratios can be explained by the attempt of banks to smooth the absolute levels of dividends as net profits have declined. Importantly, we do not find any evidence of excessive dividend payments by credit institutions with very low capital buffers or subject to high credit risk. Nevertheless, the slow adjustment of dividends to the drop in profitability has led to a loss of bank equity in the course of the crisis, exacerbating the procyclical features of the financial system. The ongoing policy initiative to tie distribution policies to the level of capital buffers above the regulatory minima is therefore an important opening to address the concerns of policymakers and other stakeholders and to improve systemic stability.

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C Appendix to chapter 4

C.1 Data description

Table 4.8: Number of observations

EU sample Number of observations per year		
year	banks in sample	of which report dividends
2002	134	48
2003	144	52
2004	355	114
2005	441	184
2006	480	194
2007	475	182
2008	422	167
2009	0	0

USA sample Number of observations per year		
year	banks in sample	of which report dividends
1998	456	456
1999	468	468
2000	477	477
2001	482	482
2002	483	483
2003	486	486
2004	494	494
2005	502	502
2006	503	503
2007	506	506
2008	489	489
2009*	464	464

* for 2009 data on the third quarter available

USA sample Number of observations per quarter		
quarter	banks in sample	of which report dividends
4q2003	486	484
1q2004	486	486
2q2004	489	486
3q2004	493	489
4q2004	494	493
1q2005	494	494
2q2005	496	494
3q2005	500	496
4q2005	502	500
1q2006	502	502
2q2006	502	502
3q2006	502	502
4q2006	503	502
1q2007	505	505
2q2007	506	505
3q2007	506	506
4q2007	506	506
1q2008	506	506
2q2008	506	506
3q2008	498	498
4q2008	489	489
1q2009	485	485
2q2009	479	480
3q2009	464	464

Table 4.9: US sample coverage

USA sample Billions of Dollar			
year	Assets of commercial banks in sample	Assets of commercial banks in the USA	Sample coverage
2003	5102.5	7808.9	65.34%
2004	6309	8488	74.33%
2005	7202.1	9843.7	73.16%
2006	8454	10821	78.13%
2007	9826.4	11809.5	83.21%
2008	10800	14001.4	77.14%

Notes: Author's calculations using data from the Flow of Funds Statistics, Board of the Governors of the Federal Reserve System.

Table 4.10: Summary statistics, US sample

Variable	Obs.	Mean	St. Dev.	Min	Max
Adjusted Dividend Payout Ratio	11868	45.31	71.68	0.00	422.61
Equity/Total Assets	12383	11.13	7.52	0.00	72.86
Capital/Risk Weighted Assets	12378	14.13	11.01	0.00	171.63
Return on Assets	11879	0.91	2.22	-23.36	13.22
Loss dummy	11880	0.11	0.31	0.00	1.00
Loss Allowances/Loans	12291	1.67	1.58	0.00	62.52
Log of Total Assets	12383	14.75	1.47	8.35	21.29

Table 4.11: Pairwise correlations, US sample

	Adjusted Dividend Payout Ratio	Equity/Total Assets	Capital/Risk Weighted Assets	Return on Assets	Loss dummy	Loss Allowances/ Loans	Log of Total Assets
Adjusted Dividend Payout Ratio	1						
Equity/Total Assets	-0.04	1.00					
Capital/Risk Weighted Assets	-0.06	0.78	1.00				
Return on Assets	0.12	0.25	0.20	1.00			
Loss dummy	-0.22	0.02	-0.01	-0.60	1.00		
Loss Allowances/Loans	-0.08	0.28	0.22	-0.10	0.24	1.00	
Log of Total Assets	0.09	-0.18	-0.20	-0.05	0.05	-0.07	1.00

Table 4.12: Summary statistics, EU sample

Baseline sample

Variable	Obs.	Mean	St. Dev.	Min	Max
Adjusted Dividend Payout Ratio	407	41.48	47.62	0.00	312.26
Equity/Total Assets	407	7.56	6.01	1.34	55.67
Return on Assets	407	0.98	1.20	-0.80	9.27
Loss dummy	407	0.04	0.19	0.00	1.00
Provisions/Loans	407	0.54	0.68	-1.14	4.26
Log of Total Assets	407	16.52	2.20	9.87	21.51

Full sample

Variable	Obs.	Mean	St. Dev.	Min	Max
Adjusted Dividend Payout Ratio	611	40.49	45.82	0.00	312.26
Equity/Total Assets	611	8.46	7.78	1.34	62.02
Return on Assets	611	1.03	1.11	-0.80	9.27
Loss dummy	611	0.03	0.17	0.00	1.00
Provisions/Loans	611	0.49	0.65	-1.14	4.26
Log of Total Assets	611	16.14	2.31	8.83	21.51

Table 4.13: Pairwise correlations, EU sample

Baseline sample

	Adjusted Dividend Payout Ratio	Equity/Total Assets	Return on Assets	Loss dummy	Provisions/Loans	Log of Total Assets
Adjusted Dividend Payout Ratio	1					
Equity/Total Assets	0.0002	1				
Return on Assets	-0.01	0.65	1.00			
Loss dummy	-0.17	-0.12	-0.24	1.00		
Provisions/Loans	-0.04	-0.06	-0.06	0.31	1.00	
Log of Total Assets	0.09	-0.61	-0.45	0.11	-0.06	1.00

Full sample

	Adjusted Dividend Payout Ratio	Equity/Total Assets	Return on Assets	Loss dummy	Provisions/Loans	Log of Total Assets
Adjusted Dividend Payout Ratio	1					
Equity/Total Assets	0.06	1				
Return on Assets	0.01	0.58	1.00			
Loss dummy	-0.15	-0.08	-0.25	1.00		
Provisions/Loans	-0.02	-0.01	-0.07	0.28	1.00	
Log of Total Assets	0.03	-0.62	-0.42	0.08	-0.08	1.00

Table 4.14: Dividend payout ratios of banks with negative profits, US sample

US sample

Dividend to net income of banks with negative net income					
quarter	mean	obs.	of which canceled dividend	min	max
4q2003	0	11	100%	0	0
1q2004	0	6	100%	0	0
2q2004	0	8	100%	0	0
3q2004	0.00	9	100%	0.00	0
4q2004	-7.70	15	67%	-23.09	0
1q2005	0.00	5	100%	0.00	0
2q2005	0.00	10	100%	0.00	0
3q2005	0.00	12	100%	0.00	0
4q2005	0.00	19	100%	0.00	0
1q2006	0.00	6	100%	0.00	0
2q2006	0.00	11	100%	0.00	0
3q2006	0.00	5	100%	0.00	0
4q2006	-13.59	15	53%	-29.36	0
1q2007	0.00	9	100%	0.00	0
2q2007	0.00	12	100%	0.00	0
3q2007	-20.39	27	67%	-71.74	0
4q2007	-48.92	68	61%	-241.54	0
1q2008	-8.80	53	79%	-63.41	0
2q2008	-35.46	91	63%	-314.15	0
3q2008	-32.09	135	66%	-469.35	0
4q2008	-25.56	219	65%	-439.75	0
1q2009	-15.27	165	80%	-294.67	0
2q2009	-7.09	199	80%	-129.05	0
3q2009	-8.93	184	82%	-160.72	0

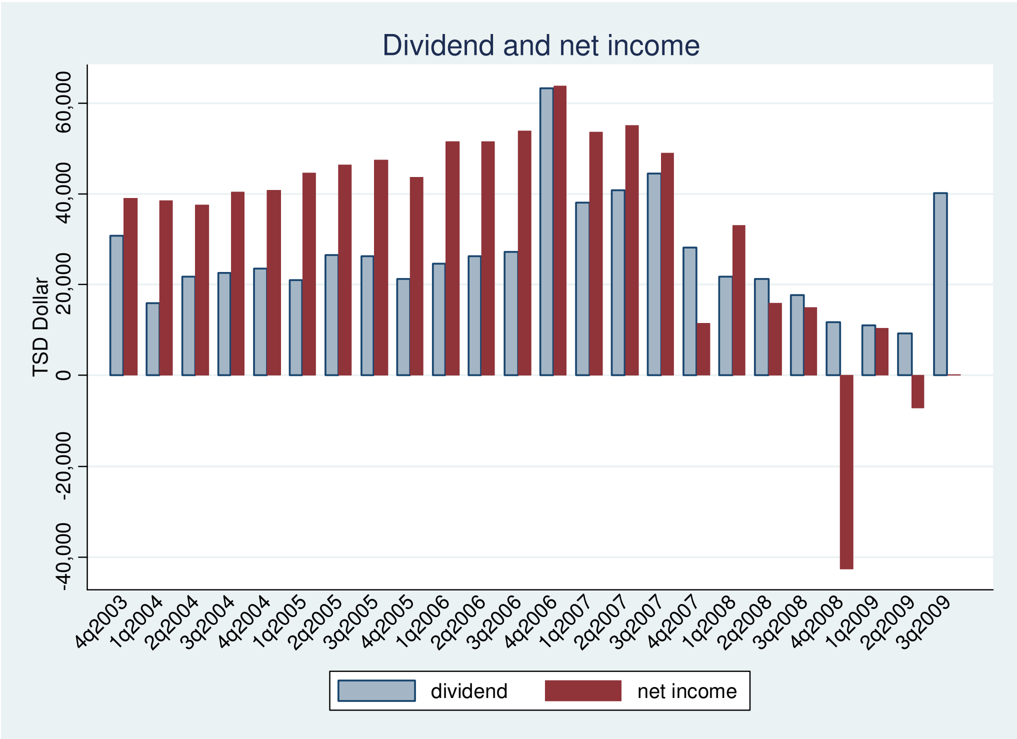

Figure 4.8: Mean of bank dividends and net income in the USA

C.2 Sensitivity analysis

Table 4.15: Fixed-effects estimation results for the crisis period: Sensitivity analysis using Equity/Total Assets, US sample

Crisis Period

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Equity/Total Assets)	2.881***				
	(0.00)				
Return on Assets		2.968***			
		(0.00)			
Loss Dummy			-60.95***		
			(0.00)		
L1.(Loss Allowances/Loans)				-11.04***	
				(0.00)	
Log of Total Assets					13.17
					(0.26)
TARP Dummy	-11.29**	-8.084	-3.108	-7.037	-9.315*
	(0.03)	*(0.11)*	*(0.51)*	*(0.17)*	*(0.07)*
Observations	4418	4417	4418	4396	4417
Number of bank clusters	506	506	506	503	506
R-squared	0.038	0.042	0.105	0.040	0.032
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(6)	(7)	(8)	(9)	(10)
L1.(Equity/Total Assets)	1.766**	1.817**	1.784**	1.859**	1.855**
	(0.03)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Return on Assets	-1.252***	-2.031***	-1.287***	-1.217***	-1.856***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy	-62.60***	-63.04***	-61.11***	-62.10***	-63.86***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-6.894***	-7.263***	-6.789***	-4.755**	-5.007**
	(0.00)	*(0.00)*	*(0.00)*	*(0.02)*	*(0.01)*
Log of Total Assets	5.445	4.934	5.285	5.688	4.053
	(0.59)	*(0.63)*	*(0.61)*	*(0.58)*	*(0.69)*
TARP Dummy	-5.041	-1.492	-1.053	7.709	-51.80***
	(0.65)	*(0.76)*	*(0.87)*	*(0.30)*	*(0.01)*
TARP*L1.(Equity/Total Assets)	0.136				4.861***
	(0.88)				*(0.00)*
TARP*Return on Assets		2.020***			1.900***
		(0.00)			*(0.01)*
TARP*Loss Dummy			-6.032		6.687
			(0.40)		*(0.40)*
TARP*L1.(Loss Allowances/Loans)				-5.701**	-7.370***
				(0.02)	*(0.00)*
Observations	4395	4395	4395	4395	4395
Number of bank clusters	503	503	503	503	503
R-squared	0.112	0.113	0.113	0.113	0.120
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.16: Fixed-effects estimation results for the crisis period: Sensitivity analysis excluding TARP participating banks, US sample

Crisis Period, banks participating in TARP excluded

Dependent Variable:	Adjusted Dividend Payout Ratio	
Estimation:	Fixed Effects	
	(1)	(2)
L1.(Capital/RWA)	1.262	
	(0.23)	
L1.(Equity/Total Assets)		1.679*
		(0.08)
Return on Assets	-1.748***	-1.768***
	(0.00)	(0.00)
Loss Dummy	-57.50***	-57.17***
	(0.00)	(0.00)
L1.(Loss Allowances/Loans)	-7.263***	-6.391***
	(0.00)	(0.01)
Log of Total Assets	9.424	11.04
	(0.53)	(0.43)
Observations	2477	2477
Number of bank clusters	282	282
R-squared	0.097	0.098
F test p-value	0	0
Bank fixed effects	yes	yes
Quarter fixed effects	yes	yes
Cluster standard errors	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.17: Fixed-effects estimation results: Sensitivity analysis univariate regressions, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio						
Estimation:	Fixed Effects						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L1.(Capital/RWA)	0.114						
	(0.56)						
L1.(Equity/Total Assets)		0.669*					
		(0.07)					
Return on Assets			2.822***				
			(0.00)				
Loss Dummy				-50.01***			
				(0.00)			
L1.(Loss Allowances/Loans)					-4.085**		
					(0.03)		
Log of Total Assets						4.836*	
						(0.09)	
TARP Dummy							-8.730**
							(0.04)
Observations	11861	11866	11867	11868	11777	11867	11853
Number of bank clusters	506	506	506	506	503	506	506
R-squared	0.023	0.024	0.028	0.059	0.025	0.023	0.023
F test p-value	0	0	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.18: Fixed-effects estimation results: Sensitivity analysis using Equity/Total Assets, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Equity/Total Assets)	1.170***	1.263***	1.172***	1.209***	1.097***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Return on Assets	-1.529***	-3.520***	-1.657***	-1.581***	-2.757*
	(0.00)	*(0.01)*	*(0.00)*	*(0.00)*	*(0.06)*
Loss Dummy	-53.62***	-53.94***	-38.68***	-53.37***	-41.07***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.694*	-1.900*	-1.848*	-1.231*	-1.101
	(0.09)	*(0.07)*	*(0.06)*	*(0.10)*	*(0.14)*
Log of Total Assets	3.304	3.451	3.888	3.464	3.250
	(0.20)	*(0.18)*	*(0.13)*	*(0.18)*	*(0.21)*
TARP Dummy	-0.364	-3.933	-3.119	6.953	2.999
	(0.97)	*(0.34)*	*(0.58)*	*(0.28)*	*(0.77)*
TARP*L1.(Equity/Total Assets)	-0.500				0.346
	(0.57)				*(0.71)*
Crisis*L1.(Equity/Total Assets)	0.395				0.443
	(0.25)				*(0.24)*
TARP*Return on Assets		1.594***			2.025***
		(0.00)			*(0.00)*
Crisis*Return on Assets		1.673			0.544
		(0.17)			*(0.71)*
TARP*Loss Dummy			-5.494		6.702
			(0.36)		*(0.31)*
Crisis*Loss Dummy			-16.91***		-16.46***
			(0.00)		*(0.00)*
TARP*L1.(Loss Allowances/Loans)				-6.145***	-6.371***
				(0.00)	*(0.00)*
Crisis*L1.(Loss Allowances/Loans)				-0.126	-0.672
				(0.86)	*(0.41)*
Observations	11761	11761	11761	11761	11761
Number of bank clusters	503	503	503	503	503
R-squared	0.064	0.065	0.065	0.065	0.066
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.19: Fixed-effects estimation results: including Lehman interaction terms, Sensitivity analysis using Equity/Total Assets, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Equity/Total Assets)	1.226***	1.277***	1.230***	1.210***	1.239***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Return on Assets	-1.536***	-3.015***	-1.826***	-1.593***	-2.835***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy	-53.80***	-55.51***	-49.53***	-53.39***	-53.12***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.797*	-2.065*	-1.944*	-1.238*	-1.476*
	(0.07)	*(0.07)*	*(0.06)*	*(0.09)*	*(0.09)*
Log of Total Assets	3.596	3.551	3.718	3.477	3.431
	(0.16)	*(0.17)*	*(0.15)*	*(0.18)*	*(0.19)*
TARP Dummy	-2.235	-3.788	-2.895	6.809	1.903
	(0.82)	*(0.36)*	*(0.61)*	*(0.28)*	*(0.85)*
TARP*L1.(Equity/Total Assets)	-0.320				0.639
	(0.70)				*(0.49)*
Lehman*L1.(Equity/Total Assets)	0.204				0.139
	(0.72)				*(0.82)*
TARP*Return on Assets		1.584***			1.829***
		(0.00)			*(0.00)*
Lehman*Return on Assets		2.821***			1.581***
		(0.00)			*(0.01)*
TARP*Loss Dummy			-6.178		5.596
			(0.30)		*(0.39)*
Lehman*Loss Dummy			-28.88***		-22.17***
			(0.00)		*(0.01)*
TARP*L1.(Loss Allowances/Loans)				-6.084***	-7.200***
				(0.00)	*(0.00)*
Lehman*L1.(Loss Allowances/Loans)				-1.357	0.490
				(0.50)	*(0.81)*
Observations	11761	11761	11761	11761	11761
Number of bank clusters	503	503	503	503	503
R-squared	0.064	0.066	0.066	0.065	0.067
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Table 4.20: Fixed-effects estimation results: Sensitivity analysis with regard to the capital ratios, US sample

Full Sample										
Dependent Variable:	Adjusted Dividend Payout Ratio									
Estimation:	Fixed Effects									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L1.(Capital/RWA)	0.0708	0.549**	0.561**	0.559***	0.527**					
	(0.71)	*(0.02)*	*(0.02)*	*(0.01)*	*(0.02)*					
L1.(Equity/Total Assets)						0.763*	1.189***	1.221***	1.058***	1.192***
						(0.06)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)		-4.262**	-4.166**	-2.455**	-3.126**		-4.241**	-4.138**	-2.620**	-3.190**
		(0.02)	*(0.02)*	*(0.03)*	*(0.03)*		*(0.02)*	*(0.02)*	*(0.04)*	*(0.03)*
TARP Dummy			-9.518**	-42.02**	-45.91**			-10.29**	6.556	4.638
			(0.03)	*(0.02)*	*(0.01)*			*(0.02)*	*(0.55)*	*(0.66)*
TARP*L1.(Capital/RWA)				4.030***	4.521***					
				(0.01)	*(0.01)*					
Crisis*L1.(Capital/RWA)				0.905***						
				(0.01)						
TARP*L1.(Loss Allowances/Loans)				-9.054***	-10.24***				-8.291***	-9.009***
				(0.00)	*(0.00)*				*(0.00)*	*(0.00)*
Crisis*L1.(Loss Allowances/Loans)				-2.155**					-1.701*	
				(0.03)					*(0.09)*	
Lehman*L1.(Capital/RWA)					0.155					
					(0.73)					
Lehman*L1.(Loss Allowances/Loans)					-2.578					-2.105
					(0.21)					*(0.31)*
Crisis*L1.(Equity/Total Assets)									0.753**	
									(0.04)	
TARP*L1.(Equity/Total Assets)									0.0139	0.334
									(0.99)	*(0.73)*
Lehman*L1.(Equity/Total Assets)										0.280
										(0.64)
Observations	11861	11772	11757	11757	11757	11866	11777	11762	11762	11762
Number of cert	506	503	503	503	503	506	503	503	503	503
R-squared	0.000	0.026	0.027	0.034	0.032	0.002	0.028	0.029	0.032	0.031
F test	0.705	0	0	0	0	0.0566	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.21: Fixed-effects estimation results: Sensitivity analysis with regard to profitability, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
Return on Assets	2.822***	-1.258***	-1.233***	-1.889	-2.128***
	(0.00)	(0.00)	(0.00)	(0.12)	(0.00)
Crisis*Return on Assets				0.0762	
				(0.95)	
TARP*Return on Assets				1.465***	1.184**
				(0.01)	(0.03)
Loss Dummy		-54.60***	-54.25***	-36.97***	-52.10***
		(0.00)	(0.00)	(0.00)	(0.00)
Crisis*Loss Dummy				-21.44***	
				(0.00)	
TARP*Loss Dummy				0.326	-2.641
				(0.96)	(0.69)
TARP Dummy			-3.345	-1.839	-0.828
			(0.39)	(0.75)	(0.89)
Lehman*Return on Assets					0.948
					(0.11)
Lehman*Loss Dummy					-22.41***
					(0.00)
Observations	11867	11867	11852	11852	11852
Number of bank clusters	506	506	506	506	506
R-squared	0.028	0.060	0.060	0.061	0.062
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.22: Fixed-effects estimation results: Sensitivity analysis using crisis2 interaction effects and Equity/Total Assets, US sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio				
Estimation:	Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
L1.(Equity/Total Assets)	1.180***	1.263***	1.197***	1.219***	1.136***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Return on Assets	-1.524***	-2.883***	-1.624***	-1.551***	-2.054**
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.02)*
Loss Dummy	-53.65***	-54.10***	-42.03***	-53.36***	-42.89***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Loss Allowances/Loans)	-1.683*	-1.958*	-1.928*	-1.312*	-1.344
	(0.09)	*(0.07)*	*(0.06)*	*(0.10)*	*(0.13)*
Log of Total Assets	3.337	3.556	3.904	3.472	3.394
	(0.20)	*(0.17)*	*(0.12)*	*(0.18)*	*(0.19)*
TARP Dummy	-0.992	-3.829	-2.281	7.562	3.222
	(0.92)	*(0.35)*	*(0.69)*	*(0.24)*	*(0.76)*
TARP*L1.(Equity/Total Assets)	-0.445				0.480
	(0.62)				*(0.62)*
Crisis2*L1.(Equity/Total Assets)	0.438				0.470
	(0.27)				*(0.26)*
TARP*Return on Assets		1.826***			2.051***
		(0.00)			*(0.00)*
Crisis2*Return on Assets		1.035			-0.192
		(0.18)			*(0.82)*
TARP*Loss Dummy			-8.244		4.041
			(0.17)		*(0.54)*
Crisis2*Loss Dummy			-14.17***		-15.97***
			(0.00)		*(0.00)*
TARP*L1.(Loss Allowances/Loans)				-6.445***	-6.824***
				(0.00)	*(0.00)*
Crisis2*L1.(Loss Allowances/Loans)				0.428	0.108
				(0.56)	*(0.90)*
Observations	11761	11761	11761	11761	11761
Number of bank clusters	503	503	503	503	503
R-squared	0.064	0.065	0.065	0.065	0.066
F test p-value	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes
Quarter fixed effects	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 4.23: Fixed-effects estimation results: Sensitivity analysis univariate regressions, EU samples

Baseline Sample

Dependent Variable:	Adjusted Dividend Payout Ratio							
Estimation:	Fixed Effects							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L1.(Equity/Total Assets)	1.099						1.214	1.263
	(0.62)						*(0.58)*	*(0.56)*
Return on Assets		-8.731***				-18.84***		
		(0.01)				*(0.00)*		
Loss Dummy			-74.06***			-91.55***		
			(0.00)			*(0.00)*		
L1.(Provisions/Loans)				0.674			1.291	1.193
				(0.85)			*(0.72)*	*(0.74)*
Log of Total Assets					6.328			6.759
					(0.71)			*(0.69)*
Observations	407	407	407	407	407	407	407	407
Number of bank clusters	131	131	131	131	131	131	131	131
R-squared	0.029	0.039	0.122	0.029	0.029	0.167	0.030	0.030
F test p-value	0.434	0.0841	3.84e-07	0.520	0.521	8.72e-07	0.504	0.582
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed.
*,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio							
Estimation:	Fixed Effects							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L1.(Equity/Total Assets)	1.294						1.344	1.392
	(0.50)						*(0.49)*	*(0.48)*
Return on Assets		-6.143**				-14.40***		
		(0.02)				*(0.00)*		
Loss Dummy			-67.55***			-80.97***		
			(0.00)			*(0.00)*		
L1.(Provisions/Loans)				2.515			2.718	2.733
				(0.38)			*(0.36)*	*(0.35)*
Log of Total Assets					5.074			6.199
					(0.74)			*(0.68)*
Observations	611	611	611	611	611	611	611	611
Number of bank clusters	221	221	221	221	221	221	221	221
R-squared	0.025	0.028	0.103	0.023	0.023	0.134	0.026	0.027
F test p-value	0.487	0.253	1.65e-07	0.562	0.657	2.81e-07	0.493	0.586
Bank fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed.
*,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Table 4.24: Fixed-effects estimation results: Sensitivity analysis using the EU full sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	1.098	0.617	0.880	1.070	0.942	0.118
	(0.58)	*(0.76)*	*(0.66)*	*(0.59)*	*(0.63)*	*(0.96)*
Return on Assets	-10.34***	-9.066**	-11.93***	-10.52***	-10.28***	-10.16***
	(0.00)	*(0.02)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.01)*
Loss Dummy	-83.51***	-91.40***	-96.57***	-46.85***	-87.97***	-46.89***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Provisions/Loans)	3.425	3.641*	3.796*	3.346	6.734***	6.673***
	(0.12)	*(0.09)*	*(0.09)*	*(0.11)*	*(0.00)*	*(0.00)*
Log of Total Assets	-4.803	-6.329	-6.611	-6.104	-5.772	-11.04
	(0.75)	*(0.68)*	*(0.66)*	*(0.69)*	*(0.69)*	*(0.46)*
State Aid Dummy	8.243	54.47	5.432	8.832	-11.52	50.47
	(0.62)	*(0.14)*	*(0.76)*	*(0.66)*	*(0.66)*	*(0.36)*
State Aid*L1.(Equity/Total Assets)		-5.978*				-7.393*
		(0.06)				*(0.05)*
Crisis*L1.(Equity/Total Assets)		0.703				0.910
		(0.51)				*(0.34)*
State Aid*Return on Assets			-2.727			-7.720
			(0.70)			(0.47)
Crisis*Return on Assets			-6.652*			-5.640*
			(0.05)			*(0.08)*
State Aid*Loss Dummy				9.871		-30.02
				(0.73)		*(0.55)*
Crisis*Loss Dummy				-53.38**		-70.05***
				(0.03)		*(0.00)*
State Aid*L1.(Provisions/Loans)					45.70	61.67
					(0.53)	*(0.29)*
Crisis*L1.(Provisions/Loans)					-48.33***	-44.33***
					(0.00)	*(0.01)*
Observations	611	611	611	611	611	611
Number of bank clusters	221	221	221	221	221	221
R-squared	0.131	0.149	0.144	0.139	0.169	0.212
F test p-value	0	0	0	0	0	0
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Table 4.25: Fixed-effects estimation results: Sensitivity analysis using the EU full sample and excluding state aid interaction terms

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	1.098	1.121	0.879	1.079	0.998	0.787
	(0.58)	*(0.57)*	*(0.66)*	*(0.58)*	*(0.61)*	*(0.70)*
Return on Assets	-10.34***	-10.45***	-12.34***	-10.58***	-10.08***	-12.11***
	(0.00)	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Loss Dummy	-83.51***	-83.99***	-95.56***	-46.93***	-89.91***	-49.05***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Provisions/Loans)	3.425	3.430	3.848*	3.342	6.750***	6.745***
	(0.12)	*(0.12)*	*(0.08)*	*(0.12)*	*(0.00)*	*(0.00)*
Log of Total Assets	-4.803	-4.654	-6.541	-6.064	-6.794	-9.905
	(0.75)	*(0.76)*	*(0.66)*	*(0.69)*	*(0.65)*	*(0.51)*
State Aid Dummy	8.243	8.277	4.669	10.63	1.109	1.884
	(0.62)	*(0.62)*	*(0.78)*	*(0.54)*	*(0.95)*	*(0.91)*
Crisis*L1.(Equity/Total Assets)		-0.123				0.0320
		(0.93)				*(0.98)*
Crisis*Return on Assets			-7.038**			-5.989**
			(0.02)			*(0.03)*
Crisis*Loss Dummy				-48.56**		-67.06***
				(0.02)		*(0.00)*
Crisis*L1.(Provisions/Loans)					-43.98***	-40.69**
					(0.01)	*(0.02)*
Observations	611	611	611	611	611	611
Number of bank clusters	221	221	221	221	221	221
R-squared	0.131	0.131	0.144	0.138	0.166	0.183
F test p-value	1.23e-07	2.55e-07	3.78e-09	2.37e-09	1.84e-07	1.17e-09
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Table 4.26: Fixed-effects estimation results: Sensitivity analysis using crisis2 interaction terms, EU baseline sample

Baseline Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	-0.363	-1.416	-0.372	-0.366	-0.650	-1.945
	(0.88)	*(0.53)*	*(0.87)*	*(0.88)*	*(0.78)*	*(0.40)*
Return on Assets	-12.89**	-12.79**	-11.31**	-13.03**	-12.14**	-10.36*
	(0.02)	*(0.02)*	*(0.05)*	*(0.02)*	*(0.02)*	*(0.07)*
Loss Dummy	-95.64***	-108.1***	-104.4***	-51.71***	-95.27***	-50.15***
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
L1.(Provisions/Loans)	1.501	1.488	1.294	1.627	4.848	4.793
	(0.57)	*(0.57)*	*(0.62)*	*(0.53)*	*(0.15)*	*(0.15)*
Log of Total Assets	-9.746	-11.87	-10.47	-11.07	-10.49	-14.74
	(0.57)	*(0.49)*	*(0.54)*	*(0.53)*	*(0.54)*	*(0.39)*
State Aid Dummy	9.087	58.33	11.96	8.445	4.504	66.59
	(0.60)	*(0.12)*	*(0.50)*	*(0.68)*	*(0.87)*	*(0.22)*
State Aid*L1.(Equity/Total Assets)		-6.238**				-6.945*
		(0.04)				*(0.06)*
Crisis2*L1.(Equity/Total Assets)		0.893*				0.978*
		(0.07)				*(0.09)*
State Aid*Return on Assets			-12.06*			-14.09
			(0.08)			(0.20)
Crisis2*Return on Assets			-0.0372			-1.255
			(0.98)			*(0.48)*
State Aid*Loss Dummy				8.499		-47.92
				(0.77)		*(0.34)*
Crisis2*Loss Dummy				-52.60**		-53.01**
				(0.05)		*(0.03)*
State Aid*L1.(Provisions/Loans)					12.39	35.07
					(0.86)	*(0.54)*
Crisis2*L1.(Provisions/Loans)					-15.47	-15.08
					(0.20)	*(0.25)*
Observations	407	407	407	407	407	407
Number of bank clusters	131	131	131	131	131	131
R-squared	0.158	0.185	0.163	0.161	0.164	0.203
F test p-value	1.24e-06	3.23e-06	9.53e-06	.	8.41e-07	.
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Table 4.27: Fixed-effects estimation results: Sensitivity analysis using crisis2 interaction terms, EU full sample

Full Sample

Dependent Variable:	Adjusted Dividend Payout Ratio					
Estimation:	Fixed Effects					
	(1)	(2)	(3)	(4)	(5)	(6)
L1.(Equity/Total Assets)	1.098	0.759	1.065	1.084	0.903	0.363
	(0.58)	*(0.70)*	*(0.60)*	*(0.58)*	*(0.65)*	*(0.86)*
Return on Assets	-10.34***	-9.660***	-9.325**	-10.39***	-9.723***	-7.389**
	(0.00)	*(0.01)*	*(0.01)*	*(0.00)*	*(0.01)*	*(0.03)*
Loss Dummy	-83.51***	-91.71***	-89.40***	-48.54**	-83.08***	-43.07**
	(0.00)	*(0.00)*	*(0.00)*	*(0.02)*	*(0.00)*	*(0.04)*
L1.(Provisions/Loans)	3.425	3.478	3.295	3.373	5.851**	5.973**
	(0.12)	*(0.10)*	*(0.14)*	*(0.12)*	*(0.02)*	*(0.02)*
Log of Total Assets	-4.803	-4.283	-5.401	-5.866	-5.639	-7.346
	(0.75)	*(0.78)*	*(0.72)*	*(0.70)*	*(0.71)*	*(0.63)*
State Aid Dummy	8.243	50.78	10.29	9.486	4.700	66.50
	(0.62)	*(0.16)*	*(0.54)*	*(0.64)*	*(0.85)*	*(0.21)*
State Aid*L1.(Equity/Total Assets)		-5.439*				-6.436*
		(0.07)				*(0.08)*
Crisis2*L1.(Equity/Total Assets)		0.510				0.551
		(0.19)				*(0.18)*
State Aid*Return on Assets			-9.733			-16.27*
			(0.11)			(0.10)
Crisis2*Return on Assets			0.0999			-0.757
			(0.94)			*(0.61)*
State Aid*Loss Dummy				1.551		-57.71
				(0.96)		*(0.24)*
Crisis2*Loss Dummy				-43.15		-46.67*
				(0.12)		*(0.09)*
State Aid*L1.(Provisions/Loans)					9.597	29.23
					(0.89)	*(0.61)*
Crisis2*L1.(Provisions/Loans)					-11.69	-13.08
					(0.19)	*(0.15)*
Observations	611	611	611	611	611	611
Number of bank clusters	221	221	221	221	221	221
R-squared	0.131	0.150	0.134	0.135	0.136	0.171
F test p-value	1.23e-07	5.55e-06	2.16e-06	8.96e-08	4.19e-07	4.85e-07
Bank fixed effects	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes
Cluster standard errors	yes	yes	yes	yes	yes	yes

Notes: P-values adjusted for clustering on bank-level in parentheses. The table shows fixed effects within estimation. Quarter dummies and a constant are suppressed. *,**,*** indicate significance at 10%, 5%, and 1% levels, respectively

Curriculum Vitae

2006-2010	Promotion in Volkswirtschaftslehre Munich Graduate School of Economics
2001-2006	Studium der Volkswirtschaftslehre, Dipl.-Volkswirtin Ludwig-Maximilians-Universität, München
2000-2001	Studium der Betriebswirtschaftslehre Hl. Kliment Ohridski Universität, Sofia, Bulgarien
2000	Abitur Romain Rolland Fremdsprachengymnasium Stara Zagora, Bulgarien