Bank liquidity creation and risk taking during distress

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Discussion Paper
Series 2: Banking and Financial Studies
No 05/2010

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Internet http://www.bundesbank.de

ISBN 978-3–86558–636–0 (Printversion)
ISBN 978-3–86558–637–7 (Internetversion)

Abstract

Liquidity creation is one of banks' raisons d'être. But what happens to liquidity creation and risk taking when a bank is identified as distressed by regulatory bodies and subjected to regulatory interventions and/or receives capital injections? What are the long-run effects of such interventions? To address these questions, we exploit a unique dataset of German universal banks for the period 1999 - 2008. Our main findings are as follows. First, regulatory interventions and capital injections are followed by lower levels of liquidity creation. The probability of a decline in liquidity creation increases to up to around 50 percent when such actions are taken. Second, bank risk taking decreases in the aftermath of regulatory interventions and capital injections. Third, while banks' liquidity creation market shares decline over the five years following such disciplinary measures, they also reduce their risk exposure over this period to become safer banks.

***Keywords*:** liquidity creation, bank distress, regulatory interventions, capital injections
***JEL Classification*:** G21, G28

Nontechnical summary

Modern financial intermediation theory emphasizes the role of banks as liquidity creators. These theories surmise that liquidity is created by financing relatively illiquid assets with relatively liquid liabilities. In other words, these theories are based upon the concept of positive maturity transformation. What is however far from clear is how banks' ability to create liquidity is affected during episodes of distress. Are there any effects on liquidity creation when regulators and bankers associations intervene into a troubled bank by, *inter alia*, imposing activity restrictions and/or demanding capital restoration measures? What happens to bank risk taking? What happens in the years following such measures?

Answers to these questions are of utmost importance to illuminate and inform the lively debate among academics and policy makers in light of the recent financial crisis because inappropriate responses to distress may impede provision of liquidity to the real economy, or, in contrast, even foster the creation of dangerous "bubbles".

In this study, we exploit a unique dataset of German universal banks for the period 1999-2008 and use recently-developed measures of liquidity creation to shed light on the connections between actions taken during times of bank distress (regulatory interventions and capital injections), liquidity creation, and risk taking. By focusing on the effects of disciplinary measures on liquidity creation instead of examining their effects on lending behavior, our research takes a more holistic perspective using a superior concept of bank output that is based on banks' intermediation capabilities.

Using two alternative regression techniques, we present three important empirical results.

First, regulatory interventions and capital injections are associated with less liquidity creation. Second, these types of interventions also reduce risk taking. These liquidity creation and risk taking reducing effects may be desirable since recently bailed out institutions in other countries such as Northern Rock in the U.K. and UBS in Switzerland were considered excessive liquidity creators. In this sense, our findings provide some suggestive evidence that regulators and bankers associations can identify banks that may create high levels of liquidity and intervene to constrain liquidity creation with the intention to preserve the institution as a going concern. Third, liquidity creation market shares decline in the years following these two types of interventions and banks further reduce their exposure to credit risk by rebalancing their loan portfolios.

Nichttechnische Zusammenfassung

Die moderne Theorie der Finanzintermediation betont die Rolle von Banken zur Bereitstellung von Liquidität für die Realwirtschaft. Diese Theorie besagt, dass Liquidität in den Bankbilanzen durch die Finanzierung von relativ illiquiden Assets mit relativ liquiden Verbindlichkeiten geschaffen wird. Mit anderen Worten, die Theorie basiert auf der Idee der positiven Fristentransformation. Weitestgehend unbeantwortet ist jedoch die Frage, wie sich es sich mit der Generierung von Liquidität in Krisenzeiten – oder auch wenn ein Institut in Schieflage gerät – verhält. Welche Wirkung hat ein Eingriff durch die Bankenaufsicht bzw. durch den Bankenverband (Einlagensicherungsfonds) auf die Liquiditätsgenerierung eines in Schieflage geratenen Instituts? Wie entwickelt sich die Bank-Performance in den Jahren nach einer solchen Maßnahme?

Antworten auf diese Fragen sind von entscheidender Bedeutung in der aktuellen Diskussion um die Ursachen und Maßnahmen zur derzeitigen Finanzkrise, da eine unangemessene Handhabung der Notlage einer Bank die Bereitstellung von Liquidität für die Realwirtschaft erschweren bzw. die Bildung von Spekulationsblasen begünstigen kann.

Diese Studie basiert auf einem Datensatz mit vertraulichen bankenaufsichtlichen Informationen zu deutschen Universalbanken für den Zeitraum 1999 bis 2008. Wir berechnen jüngst entwickelte und in der Literatur anerkannte Maße für die Liquiditätsgenerierung von Banken. Hierauf aufbauend untersuchen wir das Zusammenwirken von Liquiditätsgenerierung, regulatorischen Eingriffen und kapitalerhaltenden Maßnahmen, insbesondere im Hinblick auf in Schieflage geratene Institute. Die Tatsache, dass wir unsere Studie dabei nicht auf das Kreditvergabeverhalten von Banken (sondern auf deren Liquiditätsgenerierung) fokussieren, erlaubt eine ganzheitliche Betrachtung, gerade auch im Hinblick auf das Intermediations-Potenzial der Institute. Unsere empirischen Ergebnisse stellen sich wie folgt dar:

Erstens sind bankaufsichtliche Maßnahmen und Kapitalhilfen durch den Einlagensicherungsfonds mit einer verminderten Liquiditätsgenerierung durch die Institute verbunden. Zweitens fahren Banken nach diesen Maßnahmen auch ihre Risikobereitschaft zurück. Diese "disziplinierenden" Effekte können durchaus wünschenswert sein, da bspw. Institute wie Northern Rock (Vereinigtes Königreich) oder UBS (Schweiz) gerade in der Finanzkrise durch eine hohe Liquiditätsgenerierung auffällig wurden und schließlich gerettet werden mussten. In diesem Sinne deuten unsere Ergebnisse darauf hin, dass Bankenaufseher und Bankenverbände Institute mit (zu) hoher Liquiditätsgenerierung identifizieren und mittels Intervention deren Handlungsspielraum beschränken, mit dem Ziel, das Institut langfristig zu erhalten. Darüber hinaus zeigen wir in Langfrist-Analysen, dass disziplinierende Maßnahmen nicht nur die Liquiditätsgenerierung einschränken, sondern gleichzeitig auch in den fünf Jahren nach der Intervention die Risiken der betroffenen Institute kontinuierlich sinken bzw. deren Kapitalquoten kontinuierlich ansteigen.

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Bank liquidity creation and risk taking during distress

Introduction

Financial intermediation theory suggests that liquidity creation is one of banks' raisons d'être (e.g., Bryant, 1980; Diamond and Dybvig, 1983; Holmstrom and Tirole, 1998, Kashyap et al., 2002).[1] Banks' ability to create liquidity may be hampered during times of distress. This is a primary source of concern because bank distress can negatively affect the overall provision of liquidity to the real economy (Bernanke, 1983; Gibson, 1995; Ongena et al., 2003; Dell'Ariccia et al., 2008). Distressed banks may be subjected to different types of interventions. While regulators primarily focus on reducing risk at such banks in order to preserve them as going concerns, their actions may affect bank liquidity creation as well. It is therefore not surprising that issues surrounding bank liquidity creation and risk taking during episodes of stress lie at the heart of the discussion of academics, central banks, regulatory authorities, and policymakers (e.g., Webb, 2000; Acharya et al., 2007, 2009; Bank of England, 2008). However, there are many important questions that have yet to be answered. For example, how do regulatory interventions and capital injections into distressed banks affect their ability to create liquidity? What are the effects of these interventions on risk taking? What are the long-run effects of such interventions on liquidity creation and risk taking?

In this paper, we exploit recently-developed measures of liquidity creation that are based upon the idea of positive maturity transformation to seek answers to these questions exploiting a unique dataset of German universal banks for the period 1999 – 2008. Our research documents patterns in the data to inform the policy debate on how to deal with distressed institu-

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Klaus Schaeck was visiting the Deutsche Bundesbank when this project was initiated. He also acknowledges support from the Leverhulme Trust (Grant F/00174/Q). We thank Yener Altunbas, Owain ap Gwilym, Klaus Düllmann, Thilo Liebig, Phil Molyneux, Enrico Onali, and participants at the Bundesbank Seminar on Banking and Finance and at Bangor Business School for helpful comments and suggestions. This paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank or its staff.

[1] Another key role of banks is to transform risk (e.g., Diamond, 1984; Ramakrishnan and Thakor, 1984; Boyd and Prescott, 1986).

tions.[2] To the best of our knowledge, this is the first study that sheds light on how interventions into distressed banks by different parties affect liquidity creation by banks. By focusing on the effects of regulatory interventions and capital injections on liquidity creation instead of examining their effects on lending behavior, our research takes a more holistic perspective using a superior concept of bank output that is based on banks' intermediation capabilities and includes all on- and off-balance sheet activities. Our paper is also related to the studies about prompt corrective action and regulator's closure policies (e.g., Noe et al., 1996; Aggarwal and Jaques, 2001), and on the effect of capital injections on banks' lending behavior (e.g., Berrospide and Edge, 2009; Giannetti and Simonov, 2009).

Characteristics of the German financial system make our dataset well-suited for this type of analysis. First, Germany has a bank-based financial system, where retail and corporate customers depend heavily on liquidity provision by financial institutions (Schmidt et al., 1999). Second, our dataset from the Deutsche Bundesbank covers the entire universe of German universal banks for the period 1999 - 2008. The detailed bank data are combined with the complete set of information on interventions by the agencies in charge of regulating and supervising banks. Thus, the dataset provides a full overview of how supervisors and bankers associations discipline distressed institutions. Third, Germany offers an interesting experimental setting to examine these effects because public and cooperative banks (with the exception of the eight Landesbanks and the two apex institutions of the cooperative banks) operate in geographically delimited areas. These institutions' markets are the 301 counties that are defined by German law and are comparable to average U.S. counties in terms of population and size. Since the industry structure in Germany is characterized primarily by small and medium-sized firms that rely almost exclusively on bank financing, these borrowers usually are funded via local banks. Finally, the bank-based financial system in Germany exhibits several similarities to other continental-European financial systems such as the Austrian, Swiss, Italian, French, and Spanish systems in terms of the provision of financial services by many small- and medium-sized banks to their customers and in terms of the regulatory and institutional environments. Similarly, in the U.S., 98 percent of all banks are considered to be community banks that are the primary providers of credit for small and medium sized businesses (Ashcraft, 2001). These community banks are locally owned and operated like savings and cooperative banks in Germany. Thus,

[2] We refrain, however, from interpreting our findings in a causal sense because we observe patterns of liquidity creation only after different types of interventions, but do not observe what the patterns of liquidity creation would have been without those events.

the empirical regularities we describe below may therefore be broadly representative for a number of other countries.

To address how different forms of interventions affect banks' ability to create liquidity, we regress the percentage change in liquidity creation on variables that provide information on whether the regulators intervened (e.g., imposed restructurings, restrictions and prohibitions of lending activities), if the banks received capital injections, and a set of control variables. We run our analyses for the entire population of banks, estimate the regressions separately for small banks (total assets below the median, €566 million) and large banks (total assets above the median), run the regressions separately for weakly- and better-capitalized banks (split at the median bank's balance sheet capital ratio of 5.14 percent), and also estimate the regressions for subsamples of crisis years (2001, 2007, and 2008) and non-crisis years.

By way of preview, we find robust evidence that regulatory interventions and capital injections are associated with declines in liquidity creation. These two forms of interventions increase the probability of contractions in liquidity creation by 48 and 44 percent, respectively. When we split the sample into large and small banks, we show that capital injections are effective for both. However, regulatory interventions are only effective for small institutions. This result is driven by the fact that many of these interventions resemble restructuring orders that large banks are better able to accommodate than their smaller counterparts due to their greater resources and flexibility in meeting regulatory requirements. The results for the subsample of weakly-capitalized institutions do not differ substantially from the results for the full sample. Better-capitalized banks, however, do not experience contractions in liquidity creation after regulatory interventions, but liquidity creation decreases after capital injections. When we distinguish between crisis and non-crisis years, we find that both types of interventions have at best only limited effects on liquidity creation during crisis years.

One potential concern is that our analyses may merely capture a 'bad' bank effect on liquidity creation. Distressed banks may contract their business activities because they are in distress and the resulting contraction in liquidity creation would have also taken place absent intervention. To deal with this issue, we run regressions in which we exclude those banks that exit the market via restructuring mergers, distress mergers, and banks that were granted a moratorium or had their charter revoked. We find that liquidity creation also decreases after regulatory interventions and capital injections when 'bad' banks are excluded from the regressions, suggesting that our results are not driven by a 'bad' bank effect.

One key reason why regulators intervene in distressed banks is to reduce risk taking. We therefore also examine whether the goal of disciplining events to reduce bank risk is achieved. For this purpose, we regress the change in bank risk on the variables that capture regulatory interventions and capital injections plus controls. We use two alternative risk measures: the total risk-based capital ratio and the nonperforming loan ratio. We find that the different types of discipline generally achieve the desired objective of reducing risk taking.

We also examine what happens to liquidity creation and risk taking in the long run. To capture these effects, we focus on the change in banks' liquidity creation market shares and the change in risk taking relative to the industry five years after such interventions. Banks also generally reduce their risk taking behavior over the five years after interventions. Our analysis shows that nonperforming loans decrease after both types of interventions and that the total risk-based capital ratio increases over the five years after capital injections. These results highlight that the actions taken by regulators and bankers associations contribute to restoring distressed institutions' financial positions to ensure that these banks can remain in business as going concerns.

We organize the article as follows: Section 1 provides a brief overview of the German banking sector and the dataset. Section 2 presents the calculation of our measures of liquidity creation, followed by a discussion of the different types of discipline, and an outline of our hypotheses in Section 3. Section 4 presents the methodology. We report our main results in Section 5. In Section 6, we examine the robustness of our main results and also disentangle contractions in liquidity creation from a 'bad' bank effect. In addition, in this section we also examine whether interventions and capital injections reduce bank risk. Section 7 discusses the long-run effects of different types of interventions, and concluding remarks are offered in Section 8.

1. Institutional background and data

The German banking sector consists of three pillars: private banks, public sector banks, and credit cooperatives. While all these banks are universal banks, the three pillars are different in terms of ownership structures (Brunner et al., 2004). The pillar of private banks consists of the large banks, regional banks, and branches and subsidiaries of foreign banks. The larger private banks are organized as joint-stock companies whereas their smaller counterparts are partnerships, private limited companies or even sole proprietors. The public sector banks include savings banks and Landesbanks that are owned by governments on the city-, county-, or state-

level. The cooperative banking pillar comprises cooperative banks and central credit cooperatives. These banks are organized in the form of mutuals. Additional details about these different types of institutions, in particular with respect to geographical reach and type of business activities are provided in Altunbas et al. (2001).[3]

We obtain annual data for all these banks that operate in Germany between 1999 and 2008 from the Deutsche Bundesbank. We exclude banks from the analysis if they i) have no loans outstanding, ii) have zero deposits, iii) have unused commitments that exceed 4 times total assets, iv) if they have balance sheet items with negative values, and v) if their total assets are below € 25 million. Our dataset has 10,205 bank-year observations for 2,019 banks, of which 195 are private banks, 550 belong to the public banking sector, and 1,274 institutions are in the cooperative sector.

During the sample period, the banking sector experienced a consolidation wave. For our analysis it is important to identify mergers, as otherwise there would be unexplained spikes in liquidity creation. There are several possible ways to treat mergers:[4] (1) excluding merged banks, (2) merging banks 'backwards' into one institution over the entire time period, or (3) creating a new institution after the merger. The first option leads to loss of information as several mergers took place during the sample period. Furthermore, a bias would be created as a large fraction of the mergers are classified as 'distressed mergers,' i.e., dropping these banks would also mean dropping a large share of the most troubled institutions. The second option would be based upon the assumption that banks do not change their behavior over time, i.e., they behave as one entity prior to the merger and do not change their behavior following the merger. For our analysis we choose the third option, and create a new institution after two banks merge. This causes the number of banks in our sample to increase as we have three independently treated banks: the two pre-merger banks and the post-merger bank.[5]

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[3] The large private banks tend to operate national branch office networks, whereas smaller private banks operate in local or regional markets. Savings banks operate in locally delimited areas. They are linked to Landesbanks in three ways. First, Landesbanks are partially owned by savings banks and, second, they provide wholesale services to savings banks. Third, Landesbanks offer services to the savings banks' customers that the local savings banks are not able to provide, e.g., international banking and securities business. Cooperative banks also operate in local banking markets. The central credit cooperatives are owned by the local cooperative banks. The key task of the central cooperatives is similar to the role of Landesbanks for the savings banks.

[4] For a detailed description of possible merger treatment procedures, see Merkl and Stolz (2006).

[5] Mergers account for 7.5 percent of all observations in our sample, and repeated mergers account for 1.5 percent of all observations.

2. Bank liquidity creation

To construct our measure of liquidity creation, we employ the three–step procedure developed by Berger and Bouwman (2009a).

In the first step, we classify bank assets, liabilities, and equity as liquid, semi-liquid, or illiquid based on the ease, cost, and time it takes for customers to withdraw liquid funds from the bank, and the ease, cost and time it takes for a bank to dispose of their obligations to meet these liquidity demands. We follow a similar principle for off-balance sheet items.

A key difference between our calculation of liquidity creation and the approach in Berger and Bouwman (2009a) exists. They argue that activities should be classified based on information on both product category and maturity. However, due to data limitations, Berger and Bouwman (2009a) ultimately classify loans according to either category or maturity. The unique database from the Bundesbank, however, enables us to exploit information on both loan category and maturity when classifying these items.[6]

In the second step, we assign weights of either +½, 0, or -½ to all bank activities that are classified in the previous step. The weights are consistent with liquidity creation theory, which states that liquidity is created when banks transform liquid liabilities into illiquid assets, whereas liquidity is destroyed when liquid assets are financed by illiquid liabilities or equity. Hence, we allocate positive weights to illiquid assets and liquid liabilities, while negative weights are applied to liquid assets and illiquid liabilities and equity. We apply the intermediate weight of 0 to semi-liquid assets and liabilities, based on the assumption that semi-liquid activities fall halfway between liquid and illiquid activities. In terms of off-balance sheet items, we follow Berger and Bouwman (2009a) and apply positive weights to all illiquid guarantees. We provide simple examples of liquidity creation in Table 1.

[Table 1 *Liquidity Creation: Examples*]

In the third step, we combine the activities as classified and weighted in the first two steps to obtain two liquidity creation measures. ‘Mat Cat Fat’ represents our classification of activities based on both maturity and category with the inclusion of off-balance sheet activities. ’Mat Cat

[6] Another difference is that Berger and Bouwman’s (2009) preferred measure includes the gross fair values of off-balance sheet derivatives. Since only notional amounts are available in the Bundesbank database and since derivatives affect liquidity creation only marginally in the U.S., we exclude derivatives from our measure of liquidity creation. This exclusion should not have a large effect since most banks operate with close to matched books.

Nonfat' excludes off-balance sheet activities. The calculation of both measures is illustrated in Table 2.

[Table 2 *Classification of bank activities and construction of liquidity creation measures*]

We briefly explore how liquidity creation has evolved from 1999 to 2008 and further investigate how it varies across different types of banks. Assessing liquidity creation by 'Mat Cat Fat' (our preferred measure) and 'Mat Cat Nonfat' reveals similar trends over time. However, the level of liquidity created by banks doubles when we include off-balance sheet activities (Figure 1), a finding that is similar to the U.S. Since banks create a substantial amount of liquidity off the balance sheet we focus on 'Mat Cat Fat' in the rest of the paper. All our measures of liquidity creation are expressed in real 2000 € terms using the GDP deflator.

Based on our preferred measure 'Mat Cat Fat,' we find that liquidity creation increased sharply at the beginning of the period before it peaked in 2001 and began to decline steadily thereafter. Liquidity creation rose again from 2004 onwards whereby it reached the highest level of approximately € 1.4 trillion in 2006. The financial crisis that began in 2007 coincided with a massive plunge in liquidity creation. The level of aggregate liquidity creation at the end of the period is lower than at the beginning of our sample period. Banks created around € 1.014 trillion of liquidity in 1999, compared with € 0.875 trillion in 2008. An examination of the median bank's liquidity creation in Table 3, however, suggests that the median bank's liquidity creation increased from € 60 million in 1999 to € 155 million in 2008, we obtain a similar picture when we investigate liquidity creation divided by total assets (increases from 22 percent to over 25 percent).[7]

[Table 3 *Liquidity Creation in Germany*]

[Fig. 1 *Liquidity creation: Mat Cat Nonfat and Mat Cat Fat*]

Figure 1 presents the breakdown of liquidity creation for the three different types of banks and for the full sample. Public banks on average create the most liquidity, followed by cooperative banks, and private banks.

3. Overview of disciplinary actions and formulation of hypotheses

This section first discusses the possible actions taken by supervisors and bankers associations. Next, it formulates hypotheses to be tested.

[7] The increase in liquidity creation for the median bank is due to the fact that banks grew considerably during the sampling period. This growth is, at least partially, due to extensive merger activities in the banking sector.

3.1. Actions by supervisors and bankers associations

Supervision of banks in Germany is the joint responsibility of the Federal Financial Supervisory Authority ("Bundesanstalt für Finanzdienstleistungsaufsicht") and the German central bank ("Deutsche Bundesbank"). While the Bundesbank is primarily in charge of the on-site and off-site supervision, the Federal Financial Supervisory Authority is the responsible institution for all mandatory measures taken against banks.

Based on financial statement data, audit reports, and on-site examinations, the Bundesbank collects information about individual banks' operations and their financial positions. When banks violate the principles of the Banking Act,[8] the Bundesbank forwards this information to the Federal Financial Supervisory Authority. The actions by the Federal Financial Supervisory Authority depend on the severity of the recorded violations. In case of minor violations, it may intensify supervision or issue warnings and conduct hearings of the bank's board of directors. If the violations are more serious, it may take actions such as issuing sanctions like prohibiting the origination of new loans, dismissing senior executives, or, in the worst instances, forcing distress mergers, imposing moratoria, or revoking the charter. Before any one of those active interventions into the bank's business activities takes place, the Federal Financial Supervisory Authority typically gives the bank time to correct the deficiencies by issuing a warning letter.

Our empirical tests focus on the (serious) sanctions by the regulator that affect the banks' scope of business activities and on capital injections (to be discussed next). We do this because banks' ability to create liquidity is only affected when measures are taken that constitute an active intrusion into business operations. In contrast, it is hard to construe arguments that mere warning letters and intensified supervision have significant effects on liquidity creation.[9]

In addition to the formal regulatory interventions, the respective banking pillar's bankers associations operate a tightly-knit framework of support schemes that provide assistance to distressed institutions (Brunner et al., 2004). The support schemes not only insure the deposits of customers but also offer support in the form of capital injections operated by the bankers associations that aim to allow for independent recovery and avoid disruptions of confidence in the

[8] The Banking Act is the statutory banking supervision guide for banks in Germany.

[9] In unreported regressions, we confirm that liquidity creation is not affected when weak measures are administered by the Federal Financial Services Supervisory Agency. The results are available from the authors upon request.

system that would arise from bank closures.[10] While the private banks' deposit insurance scheme only offers one layer of protection, the support schemes for public and cooperative sector banks are particularly far reaching to ensure swift recapitalizations. That is, these institutions are part of insurance schemes that offer several layers of protection. For instance, Landesbanks are not only part of the security reserve system of all other Landesbanks but also of the protection system that consists of twelve other regional protection systems of the savings banks. In other words, thirteen protection systems are readily available to replenish distressed public banks' capital. In the unlikely case that one layer's funds are exhausted, the other protection systems will fill the gap. Similar arrangements exist in the cooperative banking sector.

While regulatory interventions are normally not known to the public, the capital restoration measures are usually reported in the banks' financial statements. Two things are important for our study. First, bankers associations are aware of interventions by regulators at an early stage, and vice versa. Second, there is no predetermined ordering with respect to the timing of when regulatory interventions and capital injections by bankers associations take place. That is, capital injections may precede or follow regulatory interventions, and one may also occur without the other.

3.2. Regulatory interventions and capital injections

We use a dummy variable ***Regulatory interventions*** into banks to capture actions by the regulator. The variable takes on the value one if one of the following six measures was imposed.

(1) Restructuring order
(2) Restrictions or prohibition of lending activities
(3) Restrictions or prohibition of deposit taking
(4) Restriction or prohibition of deposit withdrawals
(5) Restriction or prohibition of profit distributions
(6) Dismissal of senior executives[11]

[10] Recapitalizations of distressed banks are common in many countries. Oshinsky and Olin (2006) document that U.S. banks often receive capital assistance from their holding companies, and Giannetti and Simonov (2009) offer a detailed analysis of recapitalizations of banks during the crisis in Japan in the 1990s.

[11] We include measures against senior executives because these individuals determine the key funding and investment decisions of a bank, which have important effects on liquidity creation. The corporate finance literature argues that changing the figurehead is frequently associated with changes in corporate policies (e.g., Weisbach, 1988). Dismissals of senior executives account for 6.9 percent of the regulatory interventions in our sample. Re-running our regressions based on a regulatory intervention dummy that excludes the dismissals of senior executives does not materially change our inferences.

We capture ***Capital injections*** by the respective bankers associations with a dummy variable. Such capital restoration measures constitute interventions, as they underscore that mandatory capital levels have been violated and require active subsidizations. The majority of capital injections is observed in cooperative banks, followed by public and private banks.

Due to data confidentiality, we cannot disclose details of the different types of interventions and confine the overview to a breakdown by bank types and size in Table 4.

3.3. Formulation of hypotheses

We expect that regulatory interventions have a negative effect on liquidity creation as they (i) identify banks which are under severe distress, and (ii) constitute active interventions into the banks' operations that are likely to impede the scope and scale of their activities with adverse effects for their ability to create liquidity. We coin our first hypothesis the "Regulatory Discipline" Hypothesis.

H1. Regulatory Discipline Hypothesis**:** *Regulatory interventions limit banks' scope for business activities which is reflected in contractions in liquidity creation.*

The theoretical literature poses opposite views on how capital injections will affect liquidity creation. Some posit that bank capital may impede liquidity creation because it makes the bank's capital structure less fragile (e.g., Diamond and Rajan, 2000, 2001)[12] or because it 'crowds out' deposits (e.g., Gorton and Winton, 2000). We refer to these collectively as the 'financial fragility-crowding out' theories. Others focus on banks' role as risk transformers – they argue that liquidity creation exposes banks to risk (Allen and Santomero, 1998; Allen and Gale, 2004), and that higher capital improves banks' ability to absorb risk (e.g., Bhattacharya and Thakor, 1993; Repullo, 2004; von Thadden, 2004; Coval and Thakor, 2005), so higher capital ratios may allow banks to create more liquidity. We refer to these collectively as the 'risk absorption' theories. The 'financial fragility-crowding out' theories predict that liquidity creation will decrease after capital injections, while the 'risk absorption' theories predict that it will increase. Note, however, that both effects may be at play. This implies that our tests will pick up the net effect of capital injections on liquidity creation.

We formulate two hypotheses which we refer to as the 'Capital Injection Financial Fragility-Crowding Out' Hypothesis and the 'Capital Injection Risk Absorption' Hypothesis.

[12] A fragile capital structure encourages the bank to commit to monitoring its borrowers, and hence allows it to extend loans. Additional equity capital makes it harder for the less-fragile bank to commit to monitoring, which in turn hampers the bank's ability to create liquidity.

H2a. Capital Injection Financial Fragility-Crowding Out Hypothesis: *Liquidity creation decreases after capital injections.*

H2b. Capital Injection Risk Absorption Hypothesis: *Liquidity creation increases after capital injections.*

Since regulators intervene to reduce undue risk taking, we expect that risk declines after regulatory interventions. Capital injections by bankers associations should directly reduce risk both because higher capital ratios have a greater risk-absorption capacity and because they reduce moral hazard incentives.[13] We refer to the third hypothesis as the 'Risk' Hypothesis.

***H3. Risk Hypothesis*:** *Interventions are associated with reductions in risk taking.*

Table 4 provides details about the distribution of interventions the banks experienced between 1999 and 2008. In our large sample consisting of 10,205 bank-year observations, we record 57 regulatory interventions and 364 capital injections.

[Table 4 *Interventions and Capital Injections*]

4. Methodology

To investigate how liquidity creation changes when interventions by regulators and bankers associations take place, we model changes in liquidity creation as a function of regulatory interventions, capital injections, (see Section 3.3), and a set of control variables as detailed further below (see Section 4.2).

We run the regressions in changes rather than levels because this allows us to observe how changes in our explanatory variables lead to a change in liquidity creation at one particular bank in the subsequent year and avoids that our results are driven by cross-sectional variation in the data. All explanatory variables are lagged by one period.

A straightforward approach to modeling changes in liquidity creation would be to use ordinary least squares regressions. One potential drawback of using this technique is that our documented results could be merely driven by small changes in the dependent variable. It would not allow us to differentiate among sizeable increases, sizeable decreases, and constant levels of liquidity creation even though we are interested in examining whether different types of discipline give rise to substantial fluctuations in liquidity creation. We therefore employ or-

[13] While we expect that the two types of interventions are effective in reducing risk, it is also possible that risk will continue to increase, possibly leading to the ultimate failure of these institutions.

dered logit and partial proportional odds models (explained below) in which our dependent variable takes on the value of 1 if the bank experienced a drop in liquidity creation in € terms (see Table 2 for the construction of liquidity measures) relative to the previous year by more than 3 percent. It takes on the value 2 if liquidity creation remained stable within a narrow band of +/- 3 percent change, and it takes on the value 3 if liquidity creation increased by more than 3 percent. In robustness test, we use alternative cut-offs as detailed further below.

4.1. Ordered logit and partial proportional odds models

Our first model is an ordered logit model. Ordered logit models express the probability P of a change in liquidity creation Y of bank i as $j = 1,..., M$ where M is the number of classes so that

$$P(Y_i > j) = g(\alpha_j, \beta X_i) = \frac{\exp(\alpha_j + \beta X_i)}{1 + \exp(\alpha_j + \beta X_i)}, \text{ for } j = 1,2,..., M-1, \quad (1)$$

where X_i is the vector of independent variables for bank i, and α and β are the parameters of interest. The parameters α_j are the cut-off parameters for the different nodes of the dependent variable, i.e., α_1 is the intercept for a drop in liquidity creation by more than 3 percent, α_2 is the intercept for liquidity creation remaining within +/- 3 percent, and α_3 is the intercept for increases in liquidity creation by more than 3 percent; β are the slope coefficients for the explanatory variables (i.e.., regulatory interventions and capital injections).

The ordered logit model makes an important 'parallel odds' assumption. It assumes that only the cut-off parameters α_j are different across the changes in liquidity creation, whereas the slope coefficients of the link function for the parameters of interest remain identical. In the context of our study, this means that interventions are assumed to have an equiproportionate effect on the probabilities of either increases or decreases in liquidity creation.

There are fundamental reasons for why this 'parallel odds' assumption may be inappropriate when studying the effect of interventions on bank liquidity creation and risk taking during distress. Take, for example, a regulator that imposes limits on a distressed bank's ability to lend. Such a regulatory intervention is likely to impede liquidity creation. In contrast, it is difficult to imagine that such regulatory intervention increases liquidity creation. Similar lines of reasoning can be adopted for capital injections. It is therefore important to also test our hypotheses using a more flexible approach that does not make such strong assumptions. The so-called partial

proportional odds model (Williams, 2006) is a more flexible model: it allows for varying intercepts as well as for different slope coefficients so that

$$P(Y_i > j) = h(\alpha_j, \beta_j X_i) = \frac{\exp(\alpha_j + \beta_j X_i)}{1 + \exp(\alpha_j + \beta_j X_i)}, \text{ for } j = 1,2,..., M-1. \quad (2)$$

We can write the respective probabilities that Y_i takes on values $j = 1,..., M$ as

$$P(Y_i = 1) = 1 - h(\alpha_j \beta_1 X_i), \quad (3a)$$

$$P(Y_i = j) = h(\alpha_{j-1} + \beta_{j-1} X_i) - h(\alpha_j + \beta_j X_i), \text{ for } j = 2,..., M-1, \quad (3b)$$

$$P(Y_i = M) = h(\alpha_{M-1} + \beta_{M-1} X_i). \quad (3c)$$

The partial proportional odds model resembles a series of simple logit models that bunch several ordered dependent variable categories into one. Specifically, we use $M = 3$ in our paper. This means that for $j = 1$, category 1 (drop in liquidity creation by more than 3 percent) is contrasted with categories 2 and 3 (constant liquidity creation and an increase in liquidity creation by more than 3 percent, respectively); for $j = 2$, the contrast is between categories 1 and 2 versus category 3. Another benefit of the partial proportional odds model is that it allows testing for the proportional odds assumption. Prior to embarking on our empirical analysis, we discuss the control variables.

4.2. Control variables

Our analyses include control variables that are measured in changes. For ease of exposition, however, we discuss these variables below in levels.

Real ***Total assets*** is included to account for bank size. We control for bank capitalization, using the ***Equity ratio*** (equity capital to total assets) because Berger and Bouwman (2009a) have shown that bank capital is a key determinant for liquidity creation. We use ***Return on equity*** to control for profitability.

The ***Nonperforming loans ratio*** (nonperforming loans to total loans) accounts for the asset quality of the bank. We include this variable to control for bank risk taking. The ***Loan concentration index,*** measured as a Herfindahl-Hirschman index of lending activities across 15 industry sectors, controls for concentration in banks' lending activities.

We use the number of bank branches to control for the ***Geographical reach*** of the banks' intermediation activities. Our rationale for including this variable is that a dense branch office network allows a bank to intermediate more funds. The reason is that in Germany, as highlighted in the introduction, most firms rely heavily on banks as providers of financial services and credit markets are local in nature.

Real ***GDP per capita growth*** on the county level is used to control for differences in local economic development. We include the ***Interest rate spread*** (difference between 10 year and 1 year government bonds) to control for the macroeconomic environment. Since the interest rate spread affects bank liquidity creation directly, we prefer using this as a control variable instead of including year dummies.

To account for different bank types, we also include the dummy variables ***Public bank***, ***Cooperative bank***, or ***Private bank***. We omit the dummy for private banks to avoid perfect collinearity.

We present summary statistics of the control variables in Table 5. *Panel A* presents the statistics for the full sample, and *Panels B* and *C* show a detailed breakdown for the banks that experienced regulatory interventions and capital injections, respectively. While the regressions are run in changes, we present the summary statistics in levels to facilitate interpretation. A number of interesting characteristics of the banks stand out. Institutions in which the regulator intervened (*Panel B*) are considerably smaller than banks that received capital injections. *Panel C* underscores the poor performance of banks that had capital restoration measures implemented (average return on equity of -3.14 percent before the intervention) and these banks also suffer from high levels of nonperforming loans (on average 17.1 percent before the intervention).

[Table 5 *Summary Statistics for Control Variables*]

5. Main Results

This section examines what happens with liquidity creation after regulatory interventions and capital injections (Hypotheses 1 and 2). First, we offer a brief analysis of the determinants of regulatory interventions and capital injections.

5.1. The drivers of regulatory interventions and capital injections

Casual inspection of the descriptive statistics in Table 5 indicates that institutions that are subject to regulatory interventions and capital injections are bad performers and suffer from poor asset quality. To establish which factors drive interventions more formally, we use a multinomial logit model whereby the dependent variable takes on the value 0 if neither one of those two measures was observed, it takes on the value 1 if the regulators intervened, and it takes on the value 2 if the respective bankers association demanded capital restoration measures.[15] We use a similar set of explanatory variables as discussed in Section 4.2, except that these variables are now expressed in levels rather than changes. In addition, we include a dummy variable ***Distress awareness*** that takes on the value 1 if the regulator or the bankers association was already aware of some impending distress in these banks in the periods prior to a regulatory intervention or a capital injection.[16]

We approximate this awareness using information on whether an official warning letter was sent to the bank and if hearings have been held between bank staff and the regulatory authority or the bankers association with respect to dismissals of senior staff or business conduct. This dummy variable is also set to 1 in instances when the regulator or the bankers association have officially notified the bank of their disapproval of the business conduct, and when officials or the bank have been fined by the regulators. Furthermore, we also include a dummy variable ***'Bad' bank*** that takes on the value one if the bank exited the market via a distress merger, or if a moratorium was imposed, or if the bank charter was revoked in that period. All explanatory variables are lagged by one period in these tests.

The results in Table 6 underscore that poorly capitalized institutions, institutions with low return on equity, and institutions with high levels of nonperforming loans are more likely to be subject to regulatory interventions and capital injections. We also find that distress awareness is a strong predictor for regulatory interventions but not for capital injections, whereas the bad bank dummy is a good predictor for both regulatory interventions and capital injections. A buoyant macroeconomic environment reduces the odds for being subject to either regulatory

[15] In unreported tests, we examine banks that experience both regulatory interventions and capital injections. Our findings about the determinants are virtually unchanged. The results can be obtained upon request.

[16] Bankers associations are aware of impending distress in the institutions because all three types of banks are normally audited by representatives of the respective banking associations due to the mandatory membership in the respective banking pillar's deposit protection scheme. Bankers associations therefore engage in surveillance activities and are consequently well aware of the actions taken by the Federal Financial Supervisory Authority and the central bank.

interventions or capital injections, and public banks are less likely to experience such interventions than private banks.

In sum, these tests provide some preliminary evidence that both regulators and bankers associations are able to identify distressed banks that ultimately need further assistance.

5.2. Main liquidity creation results

Table 7 presents the results of our ordered logit and the less restrictive partial proportional odds models, whereby the regressions are run with changes in liquidity creation as dependent variable. As indicated above, we measure these changes as a drop in liquidity creation of at most -3 percent, constant liquidity creation (i.e., a drop up to -3 percent or an increase up to 3 percent) and an increase in liquidity creation of at least 3 percent.

[Table 7 *Ordered Logit and Partial Proportional Odds Models – Full Sample*]

The results in Table 7 highlight several important empirical patterns. We first focus on the ordered logit regressions reported in Column (1), which views increases and decreases in liquidity creation in a symmetric way and yields only one coefficient for each variable.

For ease of interpretation, we report odds ratios which are obtained by exponentiating the original coefficients. An odds ratio of one for a regulatory intervention indicates that the probability of observing an increase or a decrease in liquidity creation is equally likely. An odds ratio smaller than one suggests that the regulatory intervention is associated with a lower probability for an increase in liquidity creation. In contrast, an odds ratio above one indicates that the regulatory intervention is associated with a higher chance of increases in liquidity creation.

First, regulatory interventions are significantly associated with declines in liquidity creation. Specifically, the odds ratio of 0.59 indicates that the probability of observing an increase in liquidity creation is reduced by 41 percent in case of regulatory interventions. This is consistent with the Regulatory Discipline Hypothesis and suggests that measures such as restrictions of deposit taking and prohibitions of lending activities impede these banks' abilities to intermediate funds and show up in lower levels of liquidity creation.

Second, liquidity creation declines after capital injections. Capital injections reduce the probability of an increase in liquidity creation by 31 percent (odds ratio 0.69). This finding suggests that the Capital Injection Financial Fragility-Crowding Out Hypothesis empirically dominates the Capital Injection Risk Absorption Hypothesis. However, it is important to note

that injections in capital may come with explicit or implicit demands on banks to reduce risk, for example through portfolio adjustments, and these demands may have (possibly inadvertently) reduced liquidity creation.

Note that our analysis here focuses on the short-run effects. In the short run, the liquidity reducing effects may not necessarily be bad. Recall that regulators and bankers associations aim to preserve distressed institutions as going concern by reducing risk. Since liquidity creation involves risk, a temporary decline in liquidity creation may be needed to turn the banks around. In Section 7, we examine the long-run effects.

The results presented above are based on the ordered logit model, which views increases and decreases in liquidity creation in a symmetric way. To examine whether the slope coefficients differ, we turn to the partial proportional odds model, which breaks the regressions into two parts, and thereby allows for varying effects of the regressors over the different outcomes of the dependent variable. Specifically, the regressions in Column (2) capture the effect of the regressors on the probability of observing a drop in liquidity creation versus no change or an increase in liquidity creation combined; the coefficients in Column (3) express the effect of the regressor on the probability of a drop or no change in liquidity creation relative to an increase liquidity creation.

We again show odds ratios for ease of interpretation. In the partial proportional odds models, an odds ratio of exactly one suggests that the probability of an increase in liquidity creation is equally likely as a contraction or no change in liquidity creation. An odds ratio below one for regulatory interventions indicates that the probability for a drop in liquidity creation increases relative to observing no change or an increase in liquidity creation, whereas an odds ratio above one shows that regulatory interventions go hand in hand with increases in liquidity creation.

When we allow for varying coefficients across different outcomes, we obtain similar results for regulatory interventions and capital injections. The parameter estimates reveal no difference. To formally examine the proportional odds assumption for the coefficients being held constant, we use a Wald test and find that our model does not violate this assumption. In the rest of the paper, we will continue to report the results based on both models, because at times we do find different results. In these cases, we view the results based on the proportional odds model as more accurate.

Among the control variables, we find that size, higher capitalization, higher GDP per capita growth, and a greater interest rate spread increase the odds of increases in liquidity creation.

Relative to private banks, cooperative banks and public banks are also more likely to observe increases in liquidity creation. In contrast, riskier and more concentrated loan portfolios decrease the odds of greater liquidity creation.

We evaluate the economic significance of our findings by computing predicted probabilities for declines in liquidity creation as a function of different types of discipline. To this end, we examine how changing the dummy variables for regulatory interventions and capital injections from 0 to 1 affects the probability of observing declines in liquidity creation by at least 3 percent (all other variables are held constant at their mean). These predicted probabilities are based on Column (1) in Table 7.

The unconditional probability of a reduction in liquidity creation is 36 percent for the full sample. When we set the dummy for regulatory interventions to 1, the probability of a decline in liquidity creation increases to 48 percent after regulatory interventions and to 44 percent after capital injections. These results highlight that the actions taken by regulators and bankers associations affect banks' potential to engage in liquidity creation substantially.

5.3. Do the liquidity creation effects differ by bank size?

In the previous regressions, we controlled for bank size by including total assets (log) as a regressor. It is known, however, that banks of different size classes have fundamentally different balance sheet compositions (Berger et al., 2005) and that this affects the amount of liquidity created by these banks (Berger and Bouwman, 2009a, 2009b). Research also shows that capital and monetary policy have different effects on liquidity creation by bank size class (Berger and Bouwman, 2009a, 2010). It is important to understand whether regulatory interventions and capital injections also have different effects when we split banks into different size classes. To investigate this, we split our sample using the median bank size (€566 million) as a cut-off point and re-run our regressions. We constrain the subsequent discussion to the key variables of interest.

[Table 8 *Ordered Logit and Partial Proportional Odds Model - Small and Large Banks*]

Table 8, *Panel A*, shows the results for the small banks. The results for small banks are generally consistent with our full sample results: regulatory interventions and capital injections

have a liquidity decreasing effect, although the findings are somewhat weaker in terms of their statistical significance.[17]

Panel B depicts somewhat different results for the large institutions. We continue to find a liquidity creation decreasing effect of capital injections based on both models, but no evidence of such an effect is found for regulatory interventions. One possible explanation for the latter may be that several of these interventions are restructuring orders that relate to instructions to restructure business processes. Due to their greater resources and flexibility in terms of business models, larger banks may be better able to accommodate such restrictions.

5.4. Do the liquidity creation effects differ by bank capitalization?

Berger and Bouwman (2009a) show that capital is a key determinant for liquidity creation, while Berger and Bouwman (2009b) present evidence that banks with higher capital ratios are able to increase their market shares of liquidity creation during banking crises. Here, we examine whether weakly-capitalized banks are affected differently by interventions than better-capitalized banks. As a cut-off point, we use the median bank's equity capital ratio (5.14 percent).

[Table 9 *Ordered Logit and Partial Proportional Odds Model – Weakly- and Better-Capitalized Banks*]

Panel A in Table 9 shows that the results for weakly-capitalized banks are very similar to our main results: interventions are associated with reductions in liquidity creation for these banks. The effects are significant, and the results based on capital injections are quantitatively similar to our full sample results. The effect of regulatory interventions, however, is greater in magnitude: the odds ratio decreases from 0.59 for the full sample to 0.42 for weakly-capitalized banks, indicating that the likelihood for an increase in liquidity creation is reduced by 58 percent.

The results for the subsample of banks that operate above the median capital ratio in *Panel B* are very different. Across the ordered logit and partial proportional odds models, we find no effect of regulatory interventions on liquidity creation, likely because there is a lesser urgency to act for these banks. However, we continue to find a liquidity decreasing effect after capital injections, although the t-statistics are smaller.

[17] The capital injection effect is significant based on the proportional odds model only.

5.5. Do the liquidity creation results differ during crisis vs. non-crisis periods?

Financial crises raise the question of how effectively banks can be disciplined by regulators and private parties alike in episodes of extraordinary distress. Acharya et al. (2007) underscore that liquidity provision becomes a crucial issue during crises. Banks that experience distress may suffer even greater declines in liquidity creation in a crisis. From a policy perspective, it is therefore important to ascertain whether the effects of different forms of interventions are identical for crisis and non-crisis periods.

[Table 10 *Crisis vs. Non-Crisis Years*]

Panel A in Table 10 reports the results for the crisis years only (2001, 2007, 2008) and *Panel B* performs our analysis for the full sample excluding the non-crisis years. *Panel A* illustrates that during crisis years, regulatory interventions lose their effect on liquidity creation, which is consistent with Berger and Bouwman (2010). The evidence for capital injections is weak at best. The flexible partial proportional odds model adds information that is obscured in the ordered logit model. Capital injections only weakly reduce the likelihood of a decrease in liquidity creation vs. no change or an increase in liquidity creation.

During non-crisis years in *Panel B*, we find more support that regulatory interventions and capital injections reduce liquidity creation – the odds ratios are significant in all cases.

6. Additional tests

In this section, we perform three additional tests. We first use alternative cut-offs for the dependent variable to check for robustness. Next, we exclude 'bad' banks to ensure that our main results are not driven by distressed banks whose liquidity creation would have likely declined even absent intervention. Finally, we test the Risk Hypothesis by examining the effect of the two types of interventions on risk taking.

6.1 Alternative cut-offs

Table 11 shows robustness tests with alternative cut-offs for the dependent variable. In *Panel A*, the dependent variable takes on the value 1 if there is a drop in liquidity creation by more than 1 percent relative to the previous year, it takes on the value 2 if liquidity creation remained in a narrow band of +/- 1 percent, and it takes on the value 3 if liquidity increased by more than 1 percent. *Panel B* uses 5 percent as a cut-off point.

Our previous findings remain qualitatively unchanged. We obtain very similar results using these two alternative cutoffs.

[Table 11 *Additional Tests – Alternative Cut-Offs for the Dependent Variables and 'Bad' Banks*]

6.2 Excluding 'bad' banks

So far, we have presented evidence that regulatory interventions and capital injections are associated with declines in liquidity creation. One potential concern is that these results are not driven by the effects of interventions on liquidity creation, but simply pick up a 'bad' bank effect. Banks in distress are likely to shrink their loan portfolios, deposit levels, and off-balance sheet activities because of their distress. Thus, banks in distress are likely to reduce their liquidity creation even absent intervention. However, these banks are also prime candidates for interventions. Results from regressing the change in liquidity creation on intervention dummies may inadvertently suggest that interventions cause a decline in liquidity creation, even though the decline would have also occurred absent intervention. To address this issue, we exclude banks that exited the market via forced mergers, where moratoria have been granted, and where the bank charter was revoked. By excluding these institutions, we lose 725 observations (7.1 percent of the sample population), but mitigate the effect of detecting spurious correlations between declines in liquidity creation and the key variables of interest.

Table 11, *Panel C*, shows the results. The ordered logit models and the partial proportional odds models support to our earlier findings. Liquidity creation is more likely to decline after regulatory interventions and capital injections in this smaller sample than in the full sample Thus, the main results do not seem to be driven by a 'bad' bank effect.

6.3 The effect of regulatory interventions and capital injections on bank risk taking

Our focus so far has been on the effect of interventions by regulators and bankers associations on liquidity creation. The findings suggest that liquidity creation declines following such interventions. Since regulators and bankers associations care about the safety and soundness of the banking system, it is critical to verify if their interventions are effective in reducing risk (Risk Hypothesis).

To address this, we focus our attention on the total risk-based capital ratio, defined as tier 1 plus tier 2 capital divided by risk-weighted assets, since this is a key measure of bank risk-taking regulators use. We also examine what happens to the nonperforming loans ratio, the risk measure used as control variable in our main regressions.

Specifically, we replace the dependent variable of our main regressions with the change in risk using the two alternative risk measures. In case of the total risk-based capital ratio, the dependent variable takes on the value 1 if the ratio increases by more than 3 percent relative to the previous period, it takes on the value 2, if it remains within the interval -3 to +3 percentage, and it takes on the value 3 if it decreased by more than 3 percent. We use a similar coding for the ratio of nonperforming loans. We use the same set of variables on the right hand side of the equation as in our main regression, but omit the equity ratio in *Panel A* of Table 12, and nonperforming loans in *Panel B.*

While regulatory interventions have no effect on the total risk-based capital ratio in Table 12, *Panel A* shows that capital injections have the desired outcome. Injecting capital raises the probability for an increase in total risk-based capital by at least 29 percent in the ordered logit model. *Panel B* demonstrates that the effect of different interventions is stronger for credit risk. Regulatory interventions and capital injections reduce probabilities for increases in nonperforming loans by 44 and 26 percent, respectively. In short, our results generally support the Risk Hypothesis.

[Table 12 *Ordered Logit and Partial Proportional Odds Model – Risk Measures*]

7. Long-run effects of interventions

The results so far suggest that interventions in one year are associated with reductions in liquidity creation and reductions in risk in the following year. We now focus on the long-run effects of interventions.

In particular, we examine the long-run impact of those measures on banks' liquidity creation market share and on risk taking relative to the industry. We in effect control for the industry changes in both measures to take out the effects of any long-run secular trends. To illustrate, suppose liquidity creation increases by 2 percent over the five years after the intervention while the industry's liquidity creation goes up by 10 percent. If we did not control for the industry change, we would incorrectly conclude that the long-run effect of the intervention was positive. By focusing on liquidity creation market shares, we correctly conclude that the long-run effect is negative because the bank's market share has gone down.

Liquidity creation market share is defined as liquidity created by a bank relative to liquidity created by the entire banking sector. To account for the fact that a bank's liquidity creation market share is negative if it destroys liquidity, we focus on the percentile rank of each bank's

market share instead of its market share per se. Risk is measured as the riskiness of a bank relative to the riskiness of the entire banking sector. We use the two risk proxies used above for this purpose.

For our illustration in Table 13, we focus on banks with repeated events of regulatory interventions or capital injections.

[Table 13 *Long-Run Effects*]

Panel A uses the percentile rank of the bank's market share on the national level. The results show that the median banks' market share declines over the five years after the interventions. For instance, the rank of the median bank drops from 51.20 in the year of regulatory interventions (48.95 for capital injections) to 46.20 five years later (40.50 in case of capital injections), indicating a considerable shrinking of activities relative to other institutions. In case of regulatory interventions, these results seem to be driven by cooperatives rather than public and private banks. Whereas cooperative banks are fairly limited in terms of geographic reach and in terms of scope of activities, public and private banks may be able to adapt to the limitations imposed by regulators more quickly and resume liquidity creation at higher levels.[18] The capital injection results seem to be driven by cooperative banks and public banks. When the sample is split into small and large banks, we find that long-run market shares go down for both size classes.

The results in *Panel B* suggest that over the five years after regulatory interventions, the percentile rank of the total risk-based capital ratios of banks declines (with the exception of public banks). Over the five years after capital injections, total risk-based capital ratios increase.

The focus on the percentile ranks of nonperforming loans in *Panel C* provides strong and consistent support for the Risk Hypothesis. For all types of banks as well as for the subsamples of small and large banks we find that both types of disciplining events reduce bank risk over the 5 year period following regulatory interventions and capital injections.

[18] In unreported tests, we exclude large private banks, Landesbanks, and central cooperatives to constrain the calculation of the percentile rank of liquidity creation market shares to banks that operate in geographically delimited areas (small private banks, savings banks, and cooperative banks). That is, the denominator of the liquidity creation market share omits the large institutions that operate across different regions to compute regional market shares. The goal is to obtain an even 'cleaner' test of the effects on liquidity creation market shares. We find that liquidity provision in the local economies may be substantially affected when regulatory interventions and capital injections take place in banking markets that are dominated by these small banks whose business models emphasize close proximity to their customers.

In sum, the findings from the analysis of long-run effects suggest that over the five years after the actions taken by regulators and bankers associations both liquidity creation market shares and bank risk taking (relative to the industry) go down.

8. Concluding remarks

In this paper, we formulate and test three hypotheses related to how regulatory interventions and capital injections affect bank liquidity creation and risk taking. Since the creation of liquidity is one of the key reasons why banks exist, and regulators care about risk taking, these issues are of first-order importance for bank regulators, policy makers, and researchers.

We document several important empirical regularities using recently-developed measures of bank liquidity creation and exploiting a unique dataset of German universal banks. The results are generally consistent with our hypotheses.

First, liquidity creation decreases after regulatory interventions and capital injections. Second, bank risk taking also tends to decrease after these two types of interventions. Specifically, non-performing loans decline after both types of interventions and total risk-based capital increases after capital injections. Third, banks' liquidity creation market shares and bank risk taking (relative to the industry) decline over the five years after the interventions.

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Table 1

Liquidity Creation: Examples

Examples	**Liquidity creation**	
€1 liquid liabilities is used to fund €1 illiquid assets	½ * €1 + ½ *€1 = €1	Maximum Liquidity Creation
€1 semi-liquid liabilities is used to fund €1 semi-liquid assets	0 * €1 + 0 * €1 = €0	No Liquidity Creation
€1 illiquid liabilities or equity is used to fund €1 liquid assets	-½ * €1 + -½ * €1 = -€1	Maximum Liquidity Destruction

Table 2

Classification of bank activities and construction of liquidity creation measures

Step 1: Classify all bank activities as liquid, semi-liquid, or illiquid based on product category (Cat) and maturity (Mat) .

Step 2: Assign weights to the activities classified in Step 1.

ASSETS:

Illiquid assets (weight = ½)		**Semi-liquid assets (weight = 0)**		**Liquid assets (weight = - ½)**
Cat	***Mat***	***Cat***	***Mat***	
Loans to credit institutions	> 1 year	Loans to credit institutions	<= 1 year	Cash and due from other institutions
Loans to customers	> 1 year	Loans to customers	<= 1 year	Loans to credit institutions (due daily)
Premises				Exchange listed fixed income securities
Intangible assets				Exchange listed equities and other non fixed income securities
Non exchange listed fixed income securities				Exchange listed participation rights
Non exchange listed equities and other non fixed income securities				Exchange listed investments in unconsolidated subsidiaries
Non exchange listed investments in unconsolidated subsidiaries				
Non exchange listed participation rights				
Subordinated loans to customers				
Subordinated loans to credit institutions				
Other subordinated assets				
Other real estate owned				

LIABILITIES PLUS EQUITY:

Liquid liabilities (weight = ½)	**Semi-liquid liabilities (weight = 0)**		**Illiquid liabilities (weight = - ½)**	
Liabilities to credit institutions (overnight funds)	***Cat***	***Mat***	***Cat***	***Mat***
Other liabilities to customers (transactions deposits)	Savings deposits	All maturities	Liabilities to credit institutions	>1 year
	Time deposits	All maturities	Other tradable liabilities	>1 year
	Liabilities to credit institutions	<= 1 year	Bank's liability on bankers acceptances	
	Other tradable liabilities	<= 1 year	Subordinated debt	
			Equity	

OFF BALANCE SHEET ACTIVITIES:

Illiquid guarantees (weight = ½)
Commercial and similar letters of credit
Unused irrevocable loan commitments
Unused revocable commitments
Net standby letters of credit
All other off balance sheet liabilities

Step 3:Combined bank activities as classified in Step 1 and as weighted in Step 2 to construct "Mat Cat Fat" and "Mat Cat Nonfat" liquidity creation measures

Mat Cat Fat =

+ ½*illiquid assets + ½*liquid assets + ½*illiquid guarantees + 0* semi-liquid assets + 0* semi-liquid liabilities - ½* liquid assets - ½* illiquid liabilities - ½* equity

Mat Cat Nonfat =

+ ½*illiquid assets + ½*liquid assets + 0* semi-liquid assets + 0* semi-liquid liabilities - ½* liquid assets - ½* illiquid liabilities - ½* equity

Table 3

Liquidity Creation in Germany

		Liquidity creation in 1999			**Liquidity creation in 2008**		
		Observations	Median LC in million €	LC/TA (percent)	Observations	Median LC in million €	LC/TA (percent)
Panel A: Mat Cat Nonfat	All banks	2,019	48.44	18.43	1,212	135.87	23.26
	Private banks	195	20.26	6.34	145	44.79	9.64
	Public banks	550	166.82	17.78	434	329.50	25.53
	Cooperative banks	1,274	31.73	19.40	633	92.41	23.17
	Small banks	1,008	20.11	18.34	346	32.32	21.28
	Large banks	1,011	135.45	18.52	866	228.19	24.04
Panel B: Mat Cat Fat	All banks	2,019	60.50	22.27	1,212	155.08	25.89
	Private banks	195	53.25	13.84	145	85.01	15.04
	Public banks	550	207.82	21.24	434	357.28	27.99
	Cooperative banks	1,274	38.24	23.08	633	96.37	25.84
	Small banks	1,008	23.45	21.71	346	35.81	23.28
	Large banks	1,011	171.58	22.70	866	258.15	26.90

Table 4

Regulatory Interventions, Capital Injections, and Market Discipline

Panel A: Overview	**Observations**	**Mean**	**S.D.**	**Min**	**Median**	**Max**
Regulatory interventions	10205	0.0056	0.0745	0	0	1
Capital injections	10205	0.0357	0.1855	0	0	1
Panel B: Breakdown by bank type	**Regulatory interventions**				**Capital injections**	
Public banks	2				42	
Cooperative banks	54				295	
Private banks	1				27	
Panel C: Breakdown by bank size	**Regulatory interventions**				**Capital injections**	
Small banks	31				226	
Large banks	26				138	

Panel A provides an overview of regulatory interventions, and capital injections. We show a breakdown of these measures by bank type in Panel B and Panel C presents a breakdown of these measures by bank size.

Table 5

Summary Statistics for Control Variables

Panel A: Full sample	**Observations**	**Mean**	**S.D.**	**Min**	**Median**	**Max**
Total assets in million €	10205	3,583	30,339	25.0000	541.0000	1,370,901
Equity ratio	10205	5.4930	2.8660	0.3907	5.1360	80.3200
Return on equity	10205	11.5100	14.3200	-390.7000	11.8300	164
Nonperforming loans ratio	10205	7.1710	6.1740	0.0073	5.9260	100
Loan concentration index	10205	21.4700	17.1800	8.2770	15.1800	100
Geographical reach	10205	26.2100	211.1000	0	12	13779
GDP per capita growth	10205	1.6510	3.3280	-23.2600	1.5690	28.1900
Interest rate spread	10205	1.1960	0.6088	0.1950	1.1780	2.0260
Public bank	10205	0.3800	0.4854	0	0	1
Cooperative bank	10205	0.5276	0.4993	0	1	1
Private bank	10205	0.0924	0.2896	0	0	1
Distress awareness	10205	0.0357	0.1857	0	0	1
Bad bank	10205	0.0710	0.2569	0	0	1
Risk-based capital ratio	10160	9.2220	4.1460	4.7230	8.3800	43.0800
Panel B: Banks with regulatory interventions						
Total assets in million €	57	997.0000	1,479	48.0000	532.0000	10,276
Equity ratio	57	4.9510	1.0410	0.5051	4.8930	7.5150
Return on equity	57	5.6480	12.4000	-21.8700	4.5830	49.4300
Nonperforming loans ratio	57	13.9800	7.2000	2.55600	13.2000	36.3800
Loan concentration index	57	21.0700	11.6100	9.6280	17.1300	70.9700
Geographical reach	57	19.7900	21.2800	0	14	127
GDP per capita growth	57	0.8283	3.0750	-7.4340	0.7857	6.7250
Interest rate spread	57	1.3470	0.6017	0.1950	1.5280	2.0260
Public bank	57	0.0350	0.1856	0	0	1
Cooperative bank	57	0.9474	0.2253	0	1	1
Private bank	57	0.0175	0.1325	0	0	1
Distress awareness	57	0.4211	0.4981	0	0	1
Bad bank	57	0.3684	0.4867	0	0	1
Risk-based capital raio	57	8.2300	1.7330	4.8720	7.9700	12.6700

Panel C: Banks with capital injections						
Total assets in million €	364	2,440	11,670	26.0000	425.0000	104,301
Equity ratio	364	5.1070	2.4890	0.5051	4.7800	39.4900
Return on equity	364	-3.1470	33.6800	-390.7000	2.7040	63.9700
Nonperforming loans ratio	364	17.0700	11.5200	.0209	14.6700	76.3700
Loan concentration index	364	20.2800	12.9600	8.7200	16.1900	93.9200
Geographical reach	364	19.6700	32.3300	0	11	242
GDP per capita growth	364	1.4940	3.0210	-7.2190	1.3700	11.6900
Interest rate spread	364	1.2990	0.5608	0.1950	1.5280	2.0260
Public bank	364	0.1154	0.3199	0	0	1
Cooperative bank	364	0.8104	0.3925	0	1	1
Private bank	364	0.0741	0.2624	0	0	1
Distress awareness	364	0.1181	0.3232	0	0	1
Bad bank	364	0.4011	0.4908	0	0	1
Risk-based capital raio	364	8.6220	4.7610	4.7230	7.7990	43.0800

Panel A shows the summary statistics for the control variables in the full sample. Panels B, and C report these summary statistics separately for banks with regulatory interventions, and for banks with capital injections. While our regressions are run in changes, we report levels of the variables total assets (deflated), equity ratio, return on equity, nonperforming loans ratio, loan concentration index, geographical reach, GDP per capita growth, and interest rate spread for ease of interpretation. Public bank, cooperative bank, and commercial bank are dummy variables.

Table 6

Multinomial Logit Model: Determinants of Regulatory Interventions and Capital Injections

	(1)	(2)
Dependent variable	Regulatory intervention	Capital injection
Total assets	0.9750	0.9587***
	[-1.0817]	[-3.2155]
Equity ratio	0.7474***	0.7571***
	[-2.7883]	[-4.4941]
Return on equity	0.9689**	0.9563***
	[-2.4915]	[-9.3363]
Nonperforming loans ratio	1.1149***	1.1181***
	[6.1640]	[11.5610]
Loan concentration index	0.9844	0.9922
	[-1.3252]	[-1.2807]
GDP per capita growth	0.8967**	0.9598*
	[-2.2992]	[-1.8754]
Interest rate spread	1.0104	0.8592
	[0.0390]	[-1.2743]
Distress awareness	5.0848***	1.4403
	[5.0600]	[1.5194]
Bad bank	4.2604***	4.0967***
	[4.7381]	[9.0862]
Public bank	0.0548**	0.4993*
	[-2.2614]	[-1.9179]
Cooperative bank	1.4913	1.4993
	[0.5208]	[1.2674]
Constant	0.0112***	0.0593***
	[-4.1060]	[-5.3782]
Observations	10309	10309

We use a multinomial logit model to explain the determinants of regulatory interventions and capital injections. All other variables enter the regression in levels unless states otherwise. Distress awareness is a dummy that takes on the value one if the regulator send a warning letter to the bank in the previous year or held hearings with the bank about changes in business conduct and senior management. Bad bank is a dummy variable that takes on the value one if the bank exited the market via a distress merger, if a moratorium was imposed, or if the bank charter was revoked in that period. All models report odds ratios. We present robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 7

Ordered Logit and Partial Proportional Odds Models – Full Sample

	(1)	*(2)*	*(3)*
	Ordered logit	*Partial proportional odds model*	
Dependent variable	Δ LC	Drop in LC vs. no drop	Drop in LC and constant vs. increase in LC
Regulatory intervention	0.5886**	0.5854**	0.5854**
	[-1.9684]	[-1.9878]	[-1.9878]
Capital injection	0.6979***	0.6917***	0.6917***
	[-3.2248]	[-3.3270]	[-3.3270]
Total assets (deflated)	1.0389***	1.0374***	1.0374***
	[8.5047]	[8.5057]	[8.5057]
Equity ratio	1.2876***	1.2755***	1.2755***
	[4.5583]	[4.6268]	[4.6268]
Return on equity	1.0004	1.0003	1.0003
	[0.1731]	[0.1638]	[0.1638]
Non-performing loans ratio	0.9684***	0.9692***	0.9692***
	[-3.1225]	[-3.1223]	[-3.1223]
HHI	0.9795***	0.9797***	0.9797***
	[-4.0022]	[-4.0689]	[-4.0689]
Bank branches	0.9871	0.9868	0.9868
	[-1.1819]	[-1.2173]	[-1.2173]
GDP per capita	1.0281***	1.0289***	1.0289***
	[4.8038]	[4.8962]	[4.8962]
Interest rate spread	1.0909**	1.0466	1.1221***
	[2.5311]	[1.2272]	[3.2096]
Public bank	1.3099***	1.8050***	1.0247
	[3.3108]	[7.4965]	[0.3192]
Cooperative bank	1.0899	1.4117***	0.8826*
	[1.0695]	[4.5119]	[-1.6700]
α_1	0.7225***	1.1236	0.7889***
	[-3.6878]	[1.3706]	[-2.8608]
α_2	1.5149***		
	[4.7158]		
Observations	10205	10205	10205
Wald $\chi 2$	n/a	4.73	

We use dummy variables for regulatory interventions, and capital injections, public banks, and cooperative banks. All other variables enter the regression in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit models, and Columns (2) and (3) the partial proportional odds models. We present robust z-statistics in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

Table 8

Ordered Logit and Partial Proportional Odds Model - Small and Large Banks

Panel A: Small banks (below median 566 million €)				**Panel B: Large banks (above median 566 million €)**		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	Ordered logit	*Partial proportional odds model*		*Ordered logit*	*Partial proportional odds model*	
Dependent variable	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC
Regulatory intervention	0.5480*	0.5473*	0.5473*	0.6687	0.5419	0.8808
	[-1.7889]	[-1.7748]	[-1.7748]	[-0.9177]	[-1.4941]	[-0.2971]
Capital injection	0.7966	0.7836*	0.7836*	0.5730***	0.5693***	0.5693***
	[-1.6404]	[-1.7458]	[-1.7458]	[-3.0000]	[-3.0212]	[-3.0212]
Total assets	1.0459***	1.0393***	1.0496***	1.0390***	1.0372***	1.0372***
	[6.2980]	[5.0873]	[6.7421]	[6.4439]	[6.4632]	[6.4632]
Equity ratio	1.2378***	1.1441*	1.3257***	1.4296***	1.4023***	1.4023***
	[2.8425]	[1.7553]	[3.7700]	[4.1057]	[4.1206]	[4.1206]
Return on equity	1.0039	1.0039	1.0039	0.9968	0.9968	0.9968
	[1.3433]	[1.3518]	[1.3518]	[-1.1182]	[-1.1514]	[-1.1514]
Nonperforming loans ratio	0.9527***	0.9529***	0.9529***	0.9937	0.9949	0.9949
	[-3.6861]	[-3.7394]	[-3.7394]	[-0.3764]	[-0.3128]	[-0.3128]
Loan concentration index	0.9642***	0.9643***	0.9643***	0.9934	0.9934	0.9934
	[-4.9512]	[-5.0303]	[-5.0303]	[-0.9110]	[-0.9387]	[-0.9387]
Geographical reach	0.9650	0.9649	0.9649	0.9846	0.9844	0.9844
	[-1.0768]	[-1.0707]	[-1.0707]	[-1.2774]	[-1.3237]	[-1.3237]
GDP per capita growth	1.0195**	1.0195**	1.0195**	1.0380***	1.0392***	1.0392***
	[2.4762]	[2.4678]	[2.4678]	[4.3291]	[4.4316]	[4.4316]
Interest rate spread	1.1358**	1.1343**	1.1343**	1.0422	0.9972	1.0773
	[2.5378]	[2.5124]	[2.5124]	[0.8722]	[-0.0548]	[1.5005]
Public bank	1.2058	1.7240***	0.9341	1.3831***	1.8651***	1.0832
	[1.3233]	[3.8546]	[-0.5050]	[3.0816]	[6.2526]	[0.8210]
Cooperative bank	0.9874	1.3256**	0.7926**	1.1382	1.5645***	0.8707
	[-0.1009]	[2.4015]	[-2.0328]	[1.1599]	[4.1073]	[-1.3016]
α_1	0.6938***	1.1053	0.8890	0.7257***	1.1118	0.7469***
	[-2.6828]	[0.7829]	[-0.9373]	[-2.7163]	[0.9335]	[-2.6281]
α_2	1.3717**			1.6222***		
	[2.3279]			[4.0926]		
Observations	5103	5103	5103	5102	5102	5102
Wald $\chi 2$	n/a	10.54		n/a	6.98	

We use dummy variables for regulatory intervention and capital injections, public banks, and cooperative banks. All other variables enter the regression in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit models, and Columns (2) and (3) the partial proportional odds models. We present robust z-statistics in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

Table 9

Ordered Logit and Partial Proportional Odds Model – Weakly- and Better-Capitalized Bank

Panel A: Weakly-capitalized banks (capital ratio below 5.14 percent)				**Panel B: Better-capitalized banks (capital ratio above 5.14 percent)**		
	(1) *Ordered logit*	*(2)* *Partial proportional odds model*	*(3)*	*(1)* *Ordered logit*	*(2)* *Partial proportional odds model*	*(3)*
Dependent variable	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC
Regulatory intervention	0.4172**	0.4170**	0.4170**	0.8880	0.8974	0.8974
	[-2.3176]	[-2.3188]	[-2.3188]	[-0.3164]	[-0.2888]	[-0.2888]
Capital injection	0.6576***	0.6594***	0.6594***	0.7358*	0.7171*	0.7171*
	[-2.9728]	[-2.9611]	[-2.9611]	[-1.6521]	[-1.8206]	[-1.8206]
Total assets	1.0518***	1.0510***	1.0510***	1.0309***	1.0286***	1.0286***
	[7.4288]	[7.4772]	[7.4772]	[4.8909]	[4.8013]	[4.8013]
Equity ratio	1.8566***	2.0001***	1.7334***	1.1823***	1.1346**	1.1923***
	[4.7337]	[4.8850]	[4.3825]	[2.6907]	[2.1217]	[2.9989]
Return on equity	1.0017	1.0017	1.0017	0.9983	0.9983	0.9983
	[0.6436]	[0.6450]	[0.6450]	[-0.5119]	[-0.5497]	[-0.5497]
Nonperforming loans ratio	0.9894	0.9896	0.9896	0.9503***	0.9520***	0.9520***
	[-0.7277]	[-0.7240]	[-0.7240]	[-3.4995]	[-3.5565]	[-3.5565]
Loan concentration index	0.9767***	0.9770***	0.9770***	0.9856**	0.9857**	0.9857**
	[-3.2115]	[-3.2188]	[-3.2188]	[-1.9669]	[-2.0515]	[-2.0515]
Geographical reach	0.9776	0.9776*	0.9776*	1.0025	1.0025	1.0025
	[-1.6291]	[-1.6570]	[-1.6570]	[0.1332]	[0.1310]	[0.1310]
GDP per capita growth	1.0242***	1.0251***	1.0251***	1.0311***	1.0316***	1.0316***
	[2.7959]	[2.8813]	[2.8813]	[3.8866]	[3.9236]	[3.9236]
Interest rate spread	1.0007	0.9433	1.0393	1.1834***	1.1805***	1.1805***
	[0.0139]	[-1.0931]	[0.7493]	[3.4997]	[3.4508]	[3.4508]
Public bank	1.4460***	1.7811***	1.2212	1.1660	1.9135***	0.8059**
	[2.8589]	[4.5677]	[1.6114]	[1.3794]	[5.8354]	[-2.0223]
Cooperative bank	1.2954*	1.5670***	1.1004	0.9909	1.3438***	0.7765***
	[1.9597]	[3.4591]	[0.7512]	[-0.0888]	[3.1266]	[-2.7169]
α_1	0.7460**	1.1822	0.7371**	0.7326***	1.0169	0.8131*
	[-2.1240]	[1.2263]	[-2.2904]	[-2.6589]	[0.1561]	[-1.9381]
α_2	1.5319***			1.5742***		
	[3.0900]			[3.8818]		
Observations	5103	5103	5103	5102	5102	5102
Wald $\chi 2$	n/a	3.10		n/a	4.65	

We use dummy variables for regulatory interventions, capital injections, public banks, and cooperative banks. All other variables enter the regression in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit models, and Columns (2) and (3) the partial proportional odds models. We present robust z-statistics in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

Table 10

Crisis vs. Non-Crisis Years

	Panel A: Crisis Years Only			**Panel B: Non-Crisis Years**		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	Ordered logit	*Partial proportional odds model*		*Ordered logit*	*Partial proportional odds model*	
	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC
Regulatory intervention	0.3339	0.3303	0.3303	0.6106*	0.6100*	0.6100*
	[-1.5769]	[-1.6204]	[-1.6204]	[-1.6581]	[-1.6510]	[-1.6510]
Capital injection	0.6932	0.6336*	0.8157	0.6589***	0.6496***	0.6496***
	[-1.4648]	[-1.9116]	[-0.8141]	[-3.3115]	[-3.4322]	[-3.4322]
Total assets	1.0290***	1.0285***	1.0285***	1.0391***	1.0372***	1.0372***
	[3.5743]	[3.6997]	[3.6997]	[6.9218]	[6.8181]	[6.8181]
Equity ratio	1.1850*	1.1844*	1.1844*	1.3297***	1.3122***	1.3122***
	[1.7519]	[1.8614]	[1.8614]	[4.0407]	[4.0534]	[4.0534]
Return on equity	0.9935*	0.9935*	0.9935*	0.9982	0.9981	0.9981
	[-1.7765]	[-1.7808]	[-1.7808]	[-0.6988]	[-0.7446]	[-0.7446]
Nonperforming loans ratio	0.9755	0.9761	0.9761	0.9629***	0.9636***	0.9636***
	[-1.2427]	[-1.2517]	[-1.2517]	[-3.0930]	[-3.1118]	[-3.1118]
Loan concentration index	0.9675***	0.9677***	0.9677***	0.9852**	0.9856**	0.9856**
	[-3.7071]	[-3.7873]	[-3.7873]	[-2.2724]	[-2.2827]	[-2.2827]
Geographical reach	0.9777	0.9776	0.9776	0.9934	0.9931	0.9931
	[-0.8890]	[-0.8968]	[-0.8968]	[-0.5599]	[-0.5840]	[-0.5840]
GDP per capita growth	1.0286**	1.0294**	1.0294**	0.9932	0.9934	0.9934
	[2.4470]	[2.5069]	[2.5069]	[-0.9849]	[-0.9473]	[-0.9473]
Interest rate spread	0.8459	0.8448	0.8448	0.7706***	0.7274***	0.7916***
	[-1.5984]	[-1.6219]	[-1.6219]	[-5.8471]	[-6.4633]	[-5.0541]
Public bank	1.2717	1.6876***	1.0036	1.3194***	1.8525***	1.0318
	[1.6421]	[3.6989]	[0.0254]	[2.7773]	[6.3812]	[0.3378]
Cooperative bank	0.7396**	0.9332	0.6042***	1.3339***	1.7909***	1.0680
	[-2.1014]	[-0.5082]	[-3.7025]	[2.9190]	[6.1712]	[0.7242]
α_1	0.6564***	1.2174	0.8461	0.4097***	2.0034***	1.3906***
	[-2.6502]	[1.3108]	[-1.1202]	[-7.7928]	[6.1024]	[3.0545]
α_2	1.4368**			0.8637		
	[2.2825]			[-1.2865]		
Observations	3473	3473	3473	6732	6732	6732
Wald $\chi 2$	n/a	6.75		n/a	6.05	

We use dummy variables for regulatory interventions, capital injections, public banks, and cooperative banks. All other variables are in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit models, and Columns (2) and (3) the partial proportional odds models. We present robust z-statistics in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

Table 11

Robustness Tests – Alternative Cut-Offs for the Dependent Variables and 'Bad' banks Excluded

Panel A: 1 percent change in LC				**Panel B: 5 percent change in LC**			**Panel C: 'Bad' banks excluded**		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	Ordered logit	*Partial proportional odds model*		*Ordered logit*	*Partial proportional odds model*		*Ordered logit*	*Partial proportional odds model*	
	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC	Δ LC	Drop in LC vs. constant and increase in LC	Drop and constant LC vs. increase in LC
Regulatory intervention	0.6231*	0.6227*	0.6227*	0.6287*	0.6303*	0.6303*	0.4916**	0.4853**	0.4853**
	[-1.7243]	[-1.7287]	[-1.7287]	[-1.7057]	[-1.7130]	[-1.7130]	[-2.0093]	[-2.0483]	[-2.0483]
Capital injection	0.7229***	0.7209***	0.7209***	0.6994***	0.6249***	0.7745**	0.7721*	0.7662*	0.7662*
	[-2.8841]	[-2.9175]	[-2.9175]	[-3.2191]	[-4.1358]	[-2.1852]	[-1.8581]	[-1.9345]	[-1.9345]
Total assets	1.0379***	1.0375***	1.0375***	1.0410***	1.0354***	1.0405***	1.0399***	1.0384***	1.0384***
	[8.2668]	[8.2542]	[8.2542]	[8.7978]	[7.7021]	[9.0285]	[8.3015]	[8.3044]	[8.3044]
Equity ratio	1.3137***	1.2745***	1.3388***	1.2980***	1.2760***	1.2760***	1.2948***	1.2804***	1.2804***
	[4.9598]	[4.3167]	[5.3208]	[4.6009]	[4.6890]	[4.6890]	[4.4327]	[4.4855]	[4.4855]
Return on equity	1.0011	1.0011	1.0011	1.0016	1.0016	1.0016	1.0008	1.0007	1.0007
	[0.5518]	[0.5513]	[0.5513]	[0.7971]	[0.7980]	[0.7980]	[0.3447]	[0.3319]	[0.3319]
Nonperforming loans ratio	0.9694***	0.9695***	0.9695***	0.9705***	0.9719***	0.9719***	0.9697***	0.9702***	0.9702***
	[-3.0798]	[-3.0943]	[-3.0943]	[-2.8205]	[-2.8149]	[-2.8149]	[-2.7296]	[-2.7613]	[-2.7613]
Loan concentration index	0.9799***	0.9799***	0.9799***	0.9786***	0.9790***	0.9790***	0.9796***	0.9798***	0.9798***
	[-3.9994]	[-4.0316]	[-4.0316]	[-4.0481]	[-4.1313]	[-4.1313]	[-3.8213]	[-3.8919]	[-3.8919]
Geographical reach	0.9851	0.9850	0.9850	0.9942	0.9941	0.9941	0.9887	0.9884	0.9884
	[-1.3665]	[-1.3738]	[-1.3738]	[-0.5806]	[-0.5976]	[-0.5976]	[-0.9859]	[-1.0204]	[-1.0204]
GDP per capita growth	1.0287***	1.0322***	1.0265***	1.0270***	1.0280***	1.0280***	1.0312***	1.0320***	1.0320***
	[4.6079]	[4.9987]	[4.1605]	[4.7765]	[4.8872]	[4.8872]	[5.1068]	[5.2009]	[5.2009]
Interest rate spread	1.1070***	1.1052***	1.1052***	1.0826**	1.0414	1.1100***	1.0968***	1.0527	1.1279***
	[2.8345]	[2.7889]	[2.7889]	[2.3485]	[1.0560]	[2.8825]	[2.5993]	[1.3364]	[3.2458]
Public bank	1.3570***	1.5161***	1.2475***	1.2834***	2.0716***	0.9016	1.2960***	1.7956***	1.0118
	[3.9072]	[5.3711]	[2.8745]	[2.9198]	[9.0409]	[-1.3393]	[3.0806]	[7.2155]	[0.1496]
Cooperative bank	1.0995	1.1858**	1.0339	1.0614	1.6213***	0.7657***	1.0867	1.4161***	0.8785*
	[1.2386]	[2.2623]	[0.4445]	[0.7043]	[6.2124]	[-3.5204]	[0.9989]	[4.4009]	[-1.6776]
α_1	0.9556	0.9670	0.8742	0.5547***	1.2739***	0.7060***	0.7213***	1.1186	0.7840***
	[-0.5328]	[-0.4010]	[-1.6090]	[-6.3952]	[2.7906]	[-4.1387]	[-3.5733]	[1.2714]	[-2.8334]
α_2	1.2251**			1.8719***			1.5276***		
	[2.3817]			[6.8188]			[4.6365]		
Observations	10205	10205	10205	10205	10205	10205	9480	9480	9480
Wald $\chi 2$	n/a	2.99		n/a	10.94		n/a	4.28	

We use dummy variables for regulatory interventions and capital injections, public banks, and cooperative banks. All other variables are in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit, and Columns (2) and (3) the partial proportional odds models. Robust z-statistics are in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

Table 12

Ordered Logit and Partial Proportional Odds Model – Risk Measures as Dependent Variable

Panel A: Total risk-based capital ratio as dependent variable				Panel B: Nonperforming loans as dependent variable		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
	Ordered logit	*Partial proportional odds model*		*Ordered logit*	*Partial proportional odds model*	
	Δ Total risk-basec capital	Drop in capital vs. constant and increase in capital	Drop and constant capital vs. increase in capital	Δ Nonperforming loans	Drop in NPLs vs. constant and increase in NPLs	Drop and constant NPLs vs. increase in NPLs
Regulatory intervention	0.9644	0.9710	0.9710	0.5625*	0.5607*	0.5607*
	[-0.1284]	[-0.1078]	[-0.1078]	[-1.8349]	[-1.8411]	[-1.8411]
Capital injection	1.2939**	0.8455	1.4540***	0.7481**	0.7445***	0.7445***
	[2.0533]	[-1.2625]	[3.2370]	[-2.5573]	[-2.5984]	[-2.5984]
Total assets	0.9858***	0.9863***	0.9863***	1.0176***	1.0145***	1.0211***
	[-3.8786]	[-4.5904]	[-4.5904]	[4.2757]	[3.5304]	[5.1199]
Equity ratio	n/a	n/a	n/a	1.0743	1.0733	1.0733
				[1.4424]	[1.4768]	[1.4768]
Return on equity	1.0025	1.0030	1.0030	0.9864***	0.9863***	0.9863***
	[1.2522]	[1.5183]	[1.5183]	[-6.7507]	[-6.7957]	[-6.7957]
Nonperforming loans ratio	n/a	n/a	n/a	n/a	n/a	n/a
Loan concentration index	1.0425***	1.0417***	1.0417***	n/a	n/a	n/a
	[7.4220]	[7.9070]	[7.9070]			
Geographical reach	0.9983	0.9704*	1.0071	0.9950	0.9950	0.9950
	[-0.1697]	[-1.8537]	[0.6383]	[-0.4977]	[-0.4967]	[-0.4967]
GDP per capita growth	0.9696***	0.9954	0.9598***	1.0073	1.0073	1.0073
	[-5.5458]	[-0.6005]	[-6.5565]	[1.1901]	[1.1885]	[1.1885]
Interest rate spread	1.2142***	1.3947***	1.1654***	1.9582***	1.9643***	1.9643***
	[6.0042]	[7.3747]	[4.4553]	[19.7878]	[19.8641]	[19.8641]
Public bank	1.8503***	3.6862***	1.0583	1.1028	1.2073**	0.9776
	[6.7703]	[15.7561]	[0.7573]	[1.2847]	[2.4600]	[-0.2885]
Cooperative bank	1.9750***	3.7863***	1.1439*	1.1422*	1.2168***	1.0494
	[7.5666]	[16.9078]	[1.8482]	[1.7729]	[2.6220]	[0.6280]
α_1	0.4280***	1.1363	0.7248***	2.3726***	0.3947***	0.2774***
	[-8.7911]	[1.5441]	[-4.1479]	[10.4157]	[-11.2806]	[-15.1883]
α_2	2.4325***			3.9073***		
	[9.3299]			[16.2914]		
Observations	10160	10160	10160	10502	10502	10502
Wald $\chi 2$	n/a	3.88		n/a	10.48	

We use dummy variables for regulatory interventions and capital injections, public banks, and cooperative banks. All other variables enter the regression in changes and we use percentage changes for total assets. All models report odds ratios. Columns (1) present the ordered logit models, and Columns (2) and (3) the partial proportional odds models We present robust z-statistics in brackets. The Wald $\chi 2$ statistic tests the partial proportional odds assumption. *** p<0.01, ** p<0.05, * p<0.1

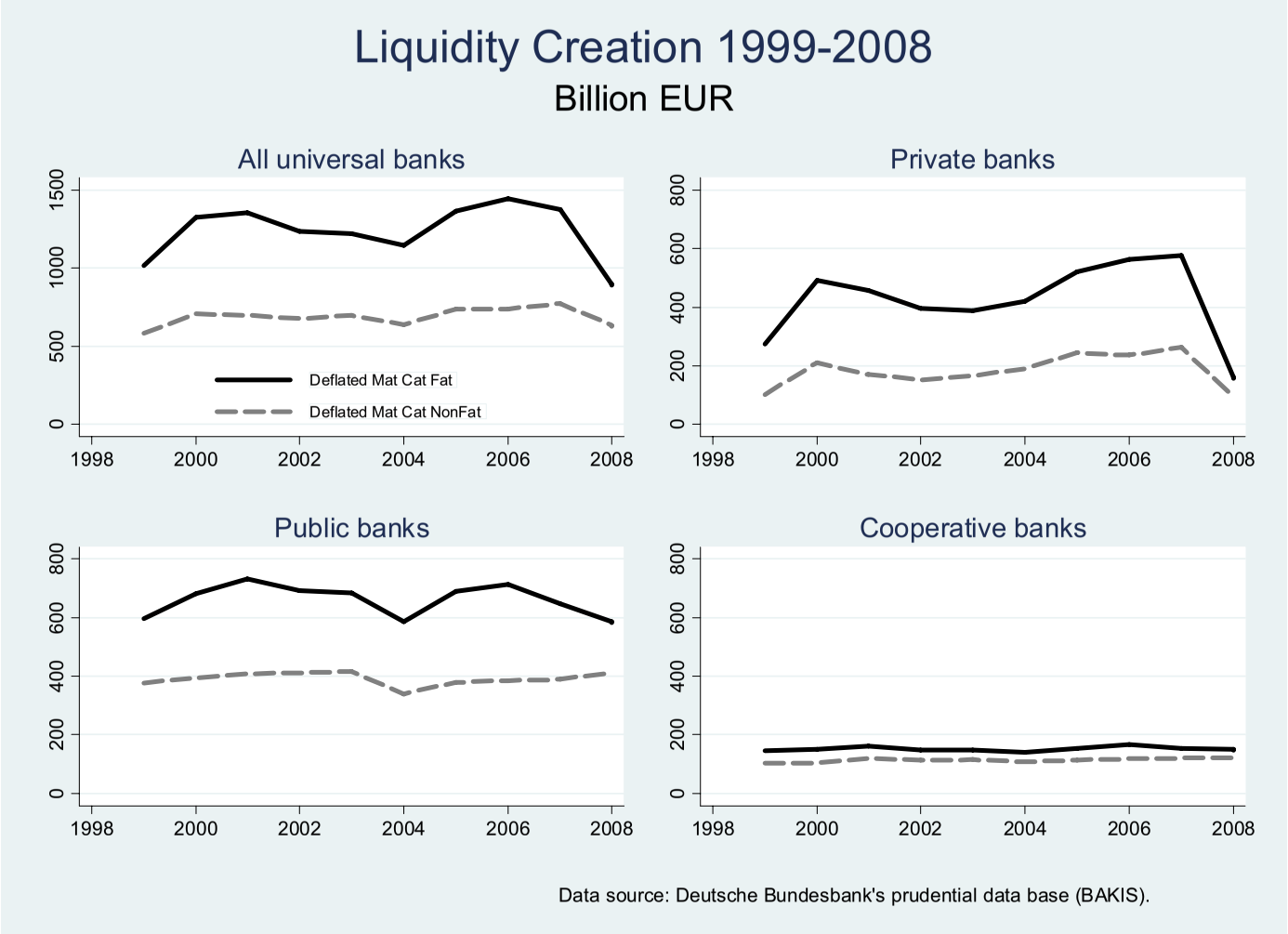
Table 13

Long-Run Effects – Summary Statistics (Medians): Market Shares and Risk Taking after Regulatory Interventions and Capital Injections

	Regulatory intervention		**Capital injection**	
	t_0	$t+5$	t_0	$t+5$
Panel A: Liquidity creation market share (nationwide percentile rank)				
All banks	51.20	46.20	48.95	40.50
Public banks	76.90	88.20	70.30	55.00
Cooperative banks	51.70	44.70	48.80	38.70
Private banks	29.80	54.60	29.80	30.40
Small banks	28.80	21.40	31.80	25.60
Large banks	59.95	55.10	63.00	52.00
Panel B: Total risk-based capital ratio/average risk-based capital ratio of all banks				
All banks	40.80	37.30	38.90	44.00
Public banks	28.65	38.40	20.55	29.90
Cooperative banks	40.80	36.20	38.30	40.50
Private banks	54.75	49.25	95.35	94.90
Small banks	35.30	26.90	41.30	44.60
Large banks	40.80	50.10	38.10	40.50
Panel C: Nonperforming loans/average non-performing loans of all banks				
All banks	90.90	73.50	90.90	79.25
Public banks	76.40	22.60	87.70	59.20
Cooperative banks	90.90	73.50	91.50	80.95
Private banks	94.80	88.10	91.00	70.20
Small banks	95.10	87.10	93.00	83.85
Large banks	87.40	69.95	89.50	77.95

We present the evolution of the percentile ranks of the median banks' liquidity creation market share for the five years following regulatory interventions and capital injections in Panel A, Panel B shows the standardized risk-based capital ratio, and Panel C shows the standardized nonperforming loans ratio.

Fig. 1
Liquidity creation: Mat Cat Nonfat and Mat Cat Fat



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