European Financial Management, Vol. 20, No. 2, 2014, 291–320
doi: 10.1111/j.1468-036X.2011.00637.x

The Liquidity Dynamics of Bank Defaults

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Abstract

We compare liquidity patterns of 10,979 failed and non-failed US banks from 2001 to mid-2010 and detect diverging capital structures: failing banks distinctively change their liquidity position about three to five years prior to default by increasing liquid assets and decreasing liquid liabilities. The build-up of liquid assets is primarily driven by short term loans, whereas long term loan positions are significantly reduced. By abandoning (positive) term transformation throughout the intermediate period prior to a default, failing banks drift away from the traditional banking business model. We show that this liquidity shift is induced by window dressing activities towards bondholders and money market investors as well as a bad client base.

Keywords: *liquidity*, *bank default*, *capital structure*, *income structure*.

JEL classification: *G21*

1. Introduction

The latest financial crisis has pronounced the importance of liquidity issues especially for banks relying on capital market sources of funding. In particular, banks approaching a

We would like to thank an anonymous referee and John Doukas for their helpful comments. We also thank Martin Brown, Matthias Hoffmann, and the participants of the CEQURA 2010 Conference in Munich, the SGF 2011 Conference in Zurich, the Annual Meeting of the German Academic Association for Business Research in Kaiserslautern and the SUERF 2011 Conference in Brussels for their comments and useful discussions on the ideas contained in this paper.

default situation put a strong emphasis on documenting their liquidity positions in order to avoid a bank run led by funding counterparties. Thereby, bank stability experienced a renaissance in importance and repositioned itself as the central concern of market participants, regulators and politicians. In order to re-establish creditability within the financial community banks were forced to build massive liquidity cushions.

Following this consideration, the basic research question of this paper is to analyse the developments of the capital structure for banks with regard to liquidity on their path towards default in comparison to their surviving peers. We aim at detecting different patterns between defaulting and non-defaulting banks: Do defaulted banks manage their liquidity positions differently than their surviving peers? What are the reasons underlying different liquidity structures? How does liquidity affect bank defaults? We are not only interested in the very recent months prior to a bank default but also in the medium to long-term aspect of liquidity management. For the purpose of our paper, we restrict the definition of bank liquidity to assets and liabilities with either highly efficient transaction markets or a maturity of three months at most.

Our basic finding with regard to capital structure is that failed banks distinctively change their liquidity position about three to five years prior to default by increasing liquid assets and decreasing liquid liabilities. This strengthening of the liquidity positions is then followed by a strong decrease in liquid assets which reverts the aforementioned change in the capital structure. Furthermore, we analyse potential reasons for banks to behave as differently as described and conclude that it is the banks governance structure and its impact induced by money market refinancing that drives the tendency towards a highly liquid balance sheet structure in ultimately defaulted banks. Additionally, we find that failing banks appear to have a distinctively worse client base: During times of economic distress, these banks face a strong increase in unused loan commitments that are drawn by struggling customers.

Based on these findings our paper contributes to the existing literature by three aspects: First, based on our analysis of the medium to long-term perspective we reveal – to our knowledge – new structural liquidity differences between failing and non-failing banks and explain these patterns with window dressing and a bad client base. Second, we are able to measure bank stability more directly via default than previous studies that mostly focus on markets proxies of bank risk. Third, in contrast to existing research we observe that not income diversification drives the insolvency risk of banks, but (endogenous) changes in the liquidity relevant capital structure.

Current discussions on regulation and capital adequacy in the context of Basle III might benefit from our analysis as liquidity issues are considered to be one main shortfall of the Basle II documents besides pro-cyclicality of capital requirements. We complement this discussion by showing that balance sheet based liquidity is a helpful indicator of bank default in the medium- to long run.

The remainder of this paper is organised as follows: Section 2 presents the different branches of literature that are relevant to this topic. Section 3 introduces the data sample and the methodology that is used throughout the empirical parts of the paper. Section 4 presents our results, which are discussed in Section 5. Section 6 concludes the paper.

2. Literature Review

A large body of literature exists that deals with the topic of liquidity within banks and its impact on various factors (e.g. default risk). Financial literature considers capital structure as being at the heart of banks' defaults and bank runs. Within this approach,

the bank's default risk is assessed by estimating the risk from the bank's assets, relating it to the bank's asset-to-liability ratio and considering incentives for future capital structure adjustments. Two strands of literature are relevant in this context: The first considers banks in a time-continuous setting where banks are subject to regulation, i.e. regulation requires the capital-to-asset ratio of banks to exceed a given level, and the deposit structure of banks is given exogenously, e.g. Fries *et al*. (1997). The second strand of literature concentrates on endogenous capital structure choices, e.g. Leland (1998). The firms considered in this strand of literature are not subject to regulation but default endogenously. Diamond and Rajan (2000) contribute to the question of bank capital structure and regulation by showing that optimal capital structure trades off effects on liquidity creation, cost of bank distress, and the ability to force borrower repayment. Using this literature as our starting point, we focus our analysis on liquidity aspects in the capital structure of banks while basing our discussion on individual bank-level data and not on a systemic view. Based on a theoretical framework, Bank and Lawrenz (2013) argue that banks with riskier assets rely to a lesser extent on deposit financing.

The second trait of relevant literature reaches beyond optimal capital structure and liquidity but focuses on profitability in the banking industry and its connection with default risk. In particular, income structure and diversification, competition, efficiency, and deposit insurance are analysed (e.g. Goddard *et al*. 2013). In an empirical analysis of European banks, Lepetit *et al*. (2008) investigate the relationship between bank risk and income structure. The study shows that banks expanding into non-interest income activities present higher insolvency risk than banks which mainly supply loans. Demirgüç-Kunt and Huizinga (2010) support this finding of increased bank fragility associated with a high proportion of non-interest income and non-deposit funding. Altunbas *et al*. (2007) document in a study on the relationship between efficiency and risk for the European banking sector a positive relationship between risk and the level of equity and liquidity and that inefficient banks tend to hold more capital but act less risky.

Profitability is also analysed in the context of explanatory factors of bank failures. In his analysis of Latin America and East Asia during the nineties, Arena (2008) concludes that bank-level fundamentals significantly affect the likelihood of bank failure. Liquidity was tested within this study as a contributing factor. However, this analysis only reveals whether there were statistical differences in bank-level fundamentals between failing and non-failing banks. It does not isolate the contribution of particular variables (e.g. short-term deposit positions) to the probabilities or timing of failure.

In their article on bank risk taking and competition, Boyd and De Nicolo (2005) analyse risk-incentive mechanisms in banks that are triggered by increased competition. Allan and Gale (2004) go even further and argue that the relationship between competition and financial stability in the banking sector is considerably more complex than a simple trade-off. They argue based on the agency problem between bank owners and public deposit insurance: The bank managers have an increased incentive to take extra risk because of deposit insurance. This extra risk that banks take as a result of the agency problem might cause bank failures.

3. Data Sample and Methodology

3.1. *Data sample*

Our empirical analysis is based on quarterly balance sheet as well as income statement data of all US banks and thrift institutions registered with and reported to the Federal

Deposit Insurance Corporation (FDIC) for the time period 01/01/2001 – 6/30/2010. For financial years before 2001 the FDIC does not report quarterly figures. Therefore, our data sample is limited to a total of 9.5 consecutive years for which quarterly reports are available. Over the investigated time period, a total of 10,979 different financial institutions, with 8,746 on average, reported to the FDIC on a quarterly basis (see Table 1). 329 of these institutions either failed in the course of the sample period or needed an assistance transaction to be able to continue business. In the following, we refer to the subsample as failed banks (F). Since we are especially interested in the dynamics before a bank default, we exclude any defaults before 2006. As our data starts only in 2001, most of these defaults only include a small number of observations and hence simply introduce additional noise to our analysis. The exclusion only accounts for 21 cases, but leaves us with data on 308 failing banks with at least 20 observations (5 years) each. As a robustness check, we perform all analyses with the full set of defaults. The results, however, remain qualitatively unchanged. The second subsample amounts to 10,671 non-failed banks (NF), which reported at least once in the course of the observation period to the FDIC and neither defaulted nor required any assistance transactions.

For each year we display the number of reports available for the respective subsample (e.g. in 2001 there were 243 reports available of banks that eventually defaulted in the subsequent years). In order to avoid a selection bias we also include all quarterly reports submitted by banks that were acquired by a competitor in the course of the observation period. Comparability and correctness of the data points reported by the banks is ensured by the standardised FDIC sourcing process. This holds in particular for the classification of individual positions. We do not incorporate SEC-regulated investment banks, because i) they apply a different business model, ii) they do not report to the FDIC and therefore do not enjoy its deposit insurance scheme and iii) their clients have different incentive structures in terms of moral hazard perspectives. By limiting the data sample to FDIC-registered banks we ensure that all banks are obliged to a comparable regulation framework.

In the first year, the sample of non-failing institutions contains 9,370 reports. This number continuously decreases to 7,857 reports filed at the end of 06/2010. The decrease of filed reports is simply a result of industry consolidation through mergers and acquisitions. The pattern behind the number of reports available for failed institutions is impacted by the recent financial crisis. Throughout the period before the current crisis, the number of reports filed every year slightly increased from 243 in 2001 to 292 in the period just before the financial crisis started in 2007. With an increasing number of banks defaulting from the beginning of 2007, this figure starts to decrease until the end of mid-2010 (86). In the last two years, the failed sample decreases dramatically as the majority of the failures happened within these two years. Generally, the failed sample contains larger institutions in terms of workforce and balance sheet total than the sample of non-failing institutions. The median of failing banks employs 53 full time equivalents (FTE) whereas the median of non-failing banks employs only 35 FTEs. The respective mean values are by far larger, which is due to the largest banks in both samples that skew mean values to higher levels. Similar relations are also reflected in the balance sheet total as a second proxy for bank size. The average failed bank tends to be bigger in terms of pure size attributes.

Table 2 relates to the average capital structure of both failed and non-failed banks. The figures are based on average mean values calculated on the basis of all available quarterly results. Following the traditional business model of banks, the asset side is dominated for both subsamples (failed and non-failed) by the position ‘securities’ and ‘net loans

Table 1
Descriptive statistics

This table presents the data from the Federal Deposit Insurance Corporation and contains quarterly balance sheet information of a total of 10,979 financial institutions for the years 2001 to 06/2010. The table reflects values as of the last available quarter of each year. The table lists the available number of reports for banks that failed (F) in the course of our observation period and banks that did not fail (NF) separately. The table also reports the number of bank defaults during the period 2006 to 2010. Additionally, the median and mean values of the number of employees and balance sheet total are listed.

Year	Reports Available NF	*Reports Available F*	*Bank Defaults*	Employees (Median) NF	*Employees (Median) F*	Employees (Mean) NF	*Employees (Mean) F*	Balance Sheet Total*(Median) NF	*Balance Sheet Total*(Median) F*	Balance Sheet Total*(Mean) NF	*Balance Sheet Total*(Mean) F*
2001	9,370	*243*	–	32	*41*	203	*282*	92,539	*121,341*	802,059	*1,474,895*
2002	9,104	*251*	–	34	*45*	213	*336*	99,201	*144,286*	881,085	*1,670,303*
2003	8,921	*261*	–	34	*48*	219	*362*	105,293	*165,808*	968,338	*1,690,209*
2004	8,704	*273*	–	34	*53*	231	*330*	110,805	*201,755*	1,101,966	*1,902,642*
2005	8,552	*283*	–	35	*59*	240	*380*	117,436	*233,198*	1,199,816	*2,209,967*
2006	8,391	*292*	*1*	36	*64*	251	*366*	123,235	*276,329*	1,334,150	*2,336,600*
2007	8,247	*292*	*4*	36	*67*	256	*373*	129,160	*291,574*	1,500,202	*2,320,210*
2008	8,048	*261*	*57*	37	*61*	263	*164*	138,388	*292,407*	1,691,035	*1,053,367*
2009	7,893	*127*	*160*	37	*50*	260	*115*	149,629	*262,771*	1,652,827	*631,744*
H1-2010	7,857	*86*	*86*	37	*47*	257	*136*	152,344	*274,495*	1,695,663	*720,887*
Total	**10,671**	***308***	***308***	**35**	***53***	**238**	***307***	**119,217**	***217,613***	**1,264,266**	***1,740,283***

* in thousand USD

Table 2

Average balance sheet structure of the non-failed and the failed sample

This table presents the average composition of the balance sheet of banks that failed in the course of our sample period and banks that did not fail. Our data contains quarterly reports to the FDIC for the period 2001 to H1-2010. The percentage values constitute the means of the pooled values of both groups. The most relevant positions are subdivided into several additional levels, each additional level marked by indention. The percentage values in each subdivision are stated in terms of the total balance sheet size.

Assets	Non-Failed	Failed	Failed	Non-Failed	Liabilities
Cash and due from depository institutions	**5.58%**	**4.44%**	**80.33%**	**80.86%**	***Total deposits***
Securities	**22.19%**	**13.66%**	3.94%	11.69%	*Foreign Deposits*
Equity Securities	0.56%	0.39%	76.39%	69.17%	*Domestic Deposits*
Debt Securities	21.63%	13.27%	13.60%	17.22%	*Transaction Accounts*
Mortgage pass-through securities backed by closed-end first lien 1-4 family residential mortgages	4.42%	3.20%	62.79%	51.96%	*Non-Transaction Accounts*
			12.86%	10.28%	*Money-market Deposit Accounts*
Other mortgage-backed securities	1.76%	1.75%	6.96%	8.34%	*Other Savings Deposits*
Fixed and floating rate debt securities	15.45%	8.32%	42.96%	33.34%	*Time Deposits*
Federal funds sold & reverse repurchase agreements	**4.07%**	**4.35%**	**2.02%**	**1.51%**	***Federal funds purchased & repurchase agreements***
Net loans & leases	**62.95%**	**71.78%**	**6.76%**	**4.85%**	***Other borrowed funds***
Loss Loan Allowance	−1.48%	−1.68%			
Unearned Income	0.09%	0.11%			
Loans & leases	64.52%	73.57%			
Fixed and floating rate closed-end loans secured by first lien on 1-4 family residential properties	15.39%	10.87%			
All Other Loans and Leases	49.13%	62.70%			
Trading account assets	**0.05%**	**0.03%**	**0.00%**	**0.01%**	***Trading liabilities***
Bank premises and fixed assets	**1.83%**	**1.93%**	**0.07%**	**0.04%**	***Subordinated debt***
Other real estate owned	**0.23%**	**0.64%**	**0.80%**	**0.97%**	***All other liabilities***
Goodwill and other intangibles	**0.53%**	**0.55%**	**10.02%**	**11.76%**	***Total equity capital***
All other assets	**2.57%**	**2.62%**			
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**Total**

& leases', whereas 'securities' in turn is dominated by debt instruments (approx. 97%). However, with the subsample of failed banks being less exposed towards 'securities' than observed in the case of non-failed banks, we already detect first signs of different asset structures. In terms of financing sources, failed banks have on average a lower equity base (10.02%) than observed in the case of non-failed ones (11.76%).

3.2. *Methodology*

In order to define a liquidity-driven capital structure, we first identify liquidity-relevant asset (LRA) and liability (LRL) positions. We base our definition of bank liquidity on a two-step approach: First, we include all assets which can be sold on highly efficient and liquid markets and all liabilities which can be withdrawn from depositors and creditors on short-notice (e.g. daily). Second, if this criterion is not applicable, all assets and liabilities with a maturity of less than three months are viewed as short-term and are therefore relevant for our analysis. In times of turbulences, short maturity structures on the asset side should allow banks to service capital outflows towards depositors and investors of short-term liabilities. The inclusion of each liquidity position is based on the consideration of how quickly an asset can be turned into cash at a predictable price or how quickly the funding is withdrawn from a bank in times of stress scenarios. Assets and liabilities with long maturities in turn are not suitable to offer comparable access to liquidity. One may argue that other balance sheet positions with maturity structures exceeding three months, e.g. long-term loans, can also be sold to third parties through securitisation transactions. However, we do not follow this argumentation since it requires a rather long structuring time or might not be accessible at all for originators (e.g. recent financial crisis).

Based on these considerations we group the selected balance sheet positions according to liquid assets and liquid liabilities. Table 3 provides a detailed overview of the selected asset and liability positions. Since the liquid security positions are quite insignificant in size, we refrain from adding a discount for potential market illiquidity. We assume that for a bank approaching a default situation, the funding counterparts (both national and international depositors as well as institutional investors and trading counterparts) will withdraw their capital according to their legal ability to do so. Thus, in times of stress, banks with a higher degree of short term debt are more exposed to cash withdrawals and therefore incorporate a higher risk of a bank run. Banks with a high portion of liquid assets in turn experience fewer difficulties to serve these capital outflows by selling-off liquid assets. Additionally, we note that the larger the gap between short-term assets and short-term liabilities, the larger the term transformation.

We provide a first overview on liquidity-relevant positions for both failed and non-failed banks covering the whole time period in Table 4. For each year we calculate the corresponding mean and median figures based on balance sheet statements available for a given year. In terms of assets we observe that failed banks tend to invest their capital into liquidity-relevant assets to a higher degree than non-failed banks. On the liability side in turn, non-failed banks are exposed, on average, to a higher degree of liquidity-relevant financing as compared to failed banks. Thus, we find first signs that positive maturity transformation is more pronounced in the case of non-failed banks. As already outlined in Table 2, equity ratios are lower for failed banks.

For the following empirical analysis we structure the data from the sample of 10,979 different quarterly balance sheets according to a time-to-default perspective (see Appendix 1). This time-to-default perspective allows us to investigate diverging patterns

Table 3

Liquidity relevant asset and liability positions

This table presents the liquidity-relevant balance sheet positions according to our understanding of bank liquidity. The definitions of the positions, as the data itself, are retrieved from the Federal Deposit Insurance Corporation. Liquidity-relevant is based either on the existence of liquid transaction markets or a maturity of three months or less.

Short-term assets	Short-term liabilities
Cash & cash-comparable: - Cash & Balances due from depository institutions (CHB). - Federal funds sold and reverse repurchase: Total federal funds sold and securities purchased under agreements to resell in domestic offices (FRE). - Trading Accounts: Securities and other assets acquired with the intent to resell in order to profit from short-term price movements (TRA). Securities: - Mortgage pass-through securities backed by closed-end first lien 1-4 family residential mortgages with a remaining maturity of three months or less (SCM). - Fixed and floating rate debt securities including securities that are issued by the US Treasury, US government agencies, and states and political subdivisions. (SCF). - Total equity securities available-for-sale at fair value not held in trading (SCE). Loans (net, with a maturity of <3 months): - Fixed and floating rate closed-end loans secured by first lien on 1-4 family residential properties held in domestic offices with a remaining maturity of three months or less (LOF). - All other loans and leases (other than closed-end loans secured by first lien on 1-4 family residential properties) with a remaining maturity of three months or less (LOO).	Trading liabilities: - Includes liability for short positions and revaluation losses on interest rate, foreign exchange rate, and other commodity and equity contracts (TRL) Federal funds purchased and repurchase agreements: - Total federal funds purchased and securities sold under agreements to repurchase in domestic offices (FRP). Foreign deposits (with a maturity of <3 months): - The sum of all foreign office deposits, including demand deposits, money market deposits, other savings deposits and time deposits (DEF). Deposits (with a maturity of <3 months): - Transaction Accounts: The sum of the following accounts held in domestic offices: demand deposits, NOW accounts, Automated Transfer Service accounts and telephone or preauthorized transfer accounts (TRX). Non-Transaction Accounts (with a maturity of <3 months): - Total money market deposit accounts held in domestic offices (MMD). Other savings deposits (excluding MMDAs, with a maturity of <3 months): - Other savings deposits held in domestic offices, aside from money market deposit accounts (OSD). - Domestic time deposits of less than $100,000, plus all open-account time deposits that are either fixed rate instruments with remaining maturities of 3 months or less or floating rate instruments subject to repricing on a quarterly or more frequent basis (TDS). - Domestic time deposits of $100,000 or more which are either fixed rate instruments with remaining maturities of 3 months or less or floating rate instruments subject to repricing on a quarterly or more frequent basis (TDL).

in terms of balance sheet structure between failed and non-failed banks. Starting with the subsample of failed banks, we first determine the quarter in which a bank defaulted or received an assistance transaction by the FDIC. Based on this quarter we assemble the individual quarters prior to the default quarter for each failed bank. In a second step we

Table 4

Descriptive statistics of the data sample

This table presents the average development of the balance sheet composition of banks that failed (F) in the course of our sample and banks that did not fail (NF). The table shows the share of liquidity-relevant assets (LR-Assets), liquidity-relevant liabilities (LR-Liabilities) and equity in relation to the balance sheet total. Median and mean values are presented. The data contains quarterly reports of US-American banks to the FDIC for the period 2001 to H1-2010. The values are reported as of end-of-year

	Share of Balance Sheet Total						Share of Balance Sheet Total					
	Median						Mean					
Year	LR-Assets NF	*LR-Assets F*	LR-Liabilities NF	*LR-Liabilities F*	Equity NF	*Equity F*	LR-Assets NF	*LR-Assets F*	LR-Liabilities NF	*LR-Liabilities F*	Equity NF	*Equity F*
2001	42.9%	41.2%	56.1%	*53.6%*	9.5%	8.6%	42.7%	*40.7%*	55.5%	*51.2%*	11.2%	*10.7%*
2002	42.6%	39.6%	56.1%	*51.1%*	9.7%	8.8%	42.6%	*38.7%*	55.5%	*49.9%*	11.4%	*10.3%*
2003	42.6%	37.0%	57.3%	*50.8%*	9.7%	8.8%	42.5%	*38.3%*	56.6%	*49.8%*	11.4%	*11.0%*
2004	44.4%	46.3%	56.5%	*49.4%*	9.8%	9.2%	43.9%	*44.9%*	55.4%	*49.1%*	11.6%	*11.7%*
2005	44.5%	52.7%	54.8%	*47.5%*	9.8%	9.1%	44.3%	*47.9%*	54.0%	*46.6%*	11.9%	*11.4%*
2006	43.7%	53.7%	53.5%	*44.4%*	10.0%	9.2%	43.5%	*48.6%*	52.7%	*44.7%*	12.4%	*11.3%*
2007	41.8%	47.6%	53.6%	*43.7%*	10.3%	8.9%	41.7%	*44.4%*	52.3%	*43.4%*	12.8%	*10.0%*
2008	35.1%	34.6%	52.9%	*38.9%*	10.0%	6.7%	36.3%	*34.2%*	51.8%	*40.1%*	11.9%	*6.6%*
2009	33.7%	29.1%	54.8%	41.9%	9.9%	3.2%	35.4%	*30.4%*	53.5%	*41.8%*	11.3%	*3.1%*
H1 - 2010	34.4%	30.1%	54.2%	38.1%	10.0%	2.0%	35.8%	*30.0%*	53.1%	*38.6%*	11.2%	*1.6%*
Total	40.7%	41.4%	55.1%	46.2%	9.9%	8.6%	41.0%	*41.3%*	54.1%	*46.0%*	11.8%	*10.02%*

calculate for each of these quarters the corresponding mean and median values for all banks that do not default between 2001 and the first half of 2010 and that filed a quarterly statement with the FDIC. For each defaulting bank, the respective non-failed sample is built using the actual, real-time values of the non-failed sample. Accordingly, the figures for the non-failed sample are weighted based on the default pattern of the failed banks. Appendix 1 displays the aggregated results for failed and non-failed banks from a rather default-driven perspective. Here, and in all further analyses, $t = 0$ represents the default point of each bank with $t = -1$ and so on referring to an ex-ante default perspective (e.g. $t = -1$ equals the last quarterly results prior to the default quarter). This approach ensures that any changes in industry dynamics during the observation period are accounted for. The empirical section that follows is based on this default-driven matching algorithm. We restrict our analysis to the period 5 years prior to default. Since we have at least 5 years of observation for every failed bank, we can ensure that our analysis is consistent in this period and might not be driven by left-censoring effects.

4. Empirical Results

4.1. *Analysing liquidity-relevant assets and liabilities*

We start our empirical analysis by focusing on liquid assets and liquid liabilities on the banks' balance sheets. Figures 1 and 2 show the median values of the different liquidity-relevant balance sheet items in relation to the respective balance sheet total.[1] The axes of the figures are kept constant to illustrate the relative importance of the different balance sheet items.

Starting with the assets plotted in Figure 1, we observe that even though the positions are fairly comparable for failed and non-failed banks, there is an outstanding exception to be noted, namely net other loans and leases. This balance sheet position consists of unsecured short-term loans and hence the risky part of the entire loan portfolio on the balance sheet. The graph shows a bell-shaped development on its path towards default with failed banks starting at a higher level. The failed banks build up a short-term position in loans of slightly above 30% of the balance sheet total approximately two years before default as opposed to fairly stable positions at non-failed banks, even though the position slightly mimics the bell-shape of the failed sample. In the advent of default failed banks accumulate a higher level of cash, whereas in earlier periods, cash holdings are constantly lower for the sample of failing banks. Hording of liquidity just prior to a default situation is less surprising, since the failed banks need to show market participants alleged capital strength in order to prevent a bank run.

In general, with regard to liquid liabilities as shown in Figure 2, the detailed plots are fairly comparable for the failed and the non-failed banking group. However, there is one interesting and substantial difference in the transaction accounts to be noted: these positions start from rather similar levels for the failed and the non-failed sample and then diverge due to the strong decrease of transaction accounts of the failed sample. This decrease is also the only non-constant movement of any of the individual balance sheet positions. Large short-term time deposits are almost identical for the failed and the non-failed banks throughout the whole period at stable values Money-market accounts

[1] Any balance sheet positions with median values that are mostly zero are excluded from detailed consideration.

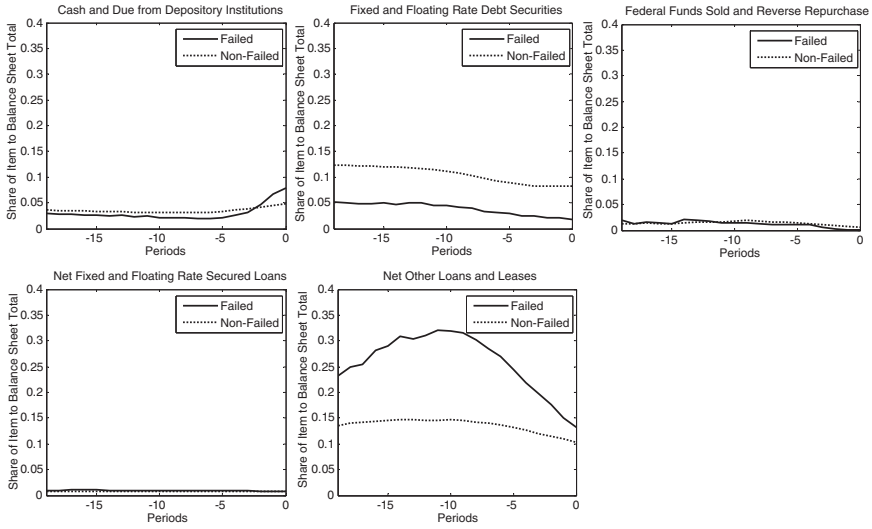


Fig. 1. Median of liquidity-relevant balance sheet items to balance sheet total, asset-side.

This figure presents the median evolution of the liquidity-relevant balance sheet positions on the asset-side for failed banks and non-failed bank separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered accordingly to reflect the default pattern of failing banks and hence control for any industry-wide developments. Any short-term asset positions with a median of zero in all quarters are not included in the figure. All values are calculated in relation to the balance sheet total.

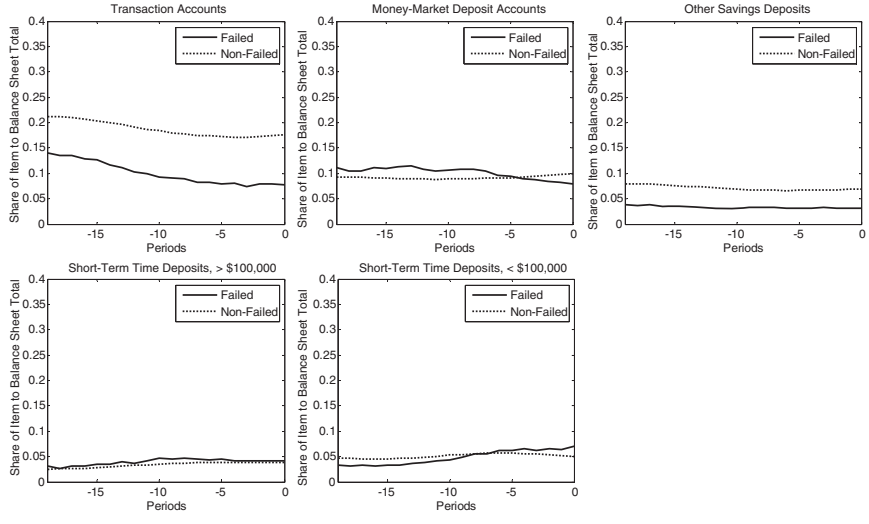


Fig. 2. Median of liquidity-relevant balance sheet items to balance sheet total, liabilities-side.

This figure presents the median evolution of the liquidity-relevant balance sheet positions on the liabilities-side for failed banks and non-failed bank separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered accordingly to reflect the default pattern of failing banks and hence control for any industry-wide developments. Any short-term liabilities positions with a median of zero in all quarters are not included in the figure. All values are calculated in relation to the balance sheet total.

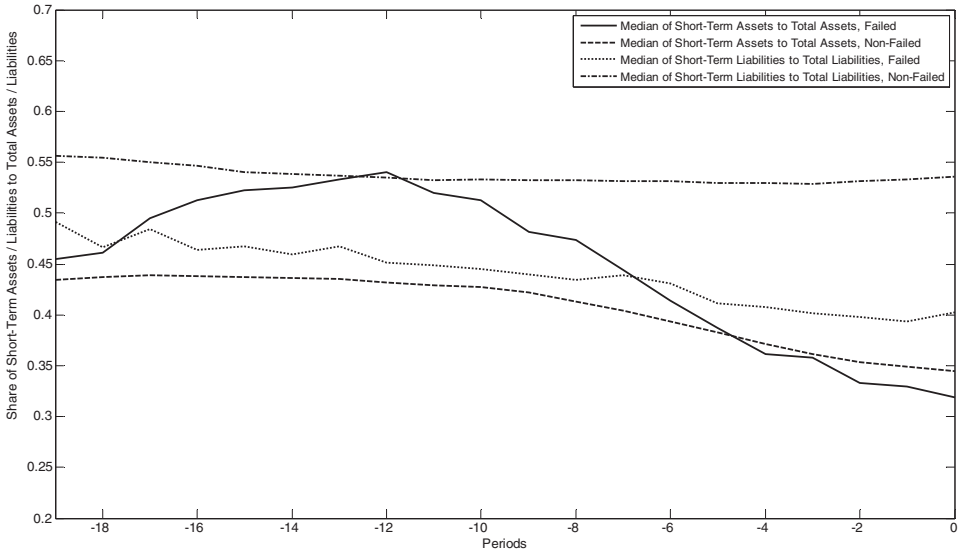


Fig. 3. Median of liquidity-relevant assets/liabilities to total balance sheet size over time.

This figure presents the median evolution of the liquidity-relevant balance sheet positions for failed banks and non-failed bank separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered accordingly to reflect the default pattern of failing banks and hence control for any industry-wide developments. The values are calculated in relation to the balance sheet total.

are slightly higher on a rather constant level for the failed sample, whereas in the last two quarters prior to the default point the failed banks lose them proportionally to the surviving peers as a refinancing source. The small short-term time deposits are slightly smaller for the failed sample but the difference is negligible. Only in the last two to four quarters are failed banks able to attract more short-term time deposits below $100,000, which is particularly interesting since this deposit accounts are fully secured by the FDIC in case of a default. Finally, there is a constant difference of roughly 4% to be identified with regard to other savings deposits, i.e. the non-failing banks constantly show a higher value for this item relative to the balance sheet total. This difference, however, remains stable even in the advent of default.

Figure 3 summarises the development of total liquidity-relevant assets and liabilities (median values) for the two samples of failed and non-failed banks. We conduct the same analysis for mean values which produces similar yet less pronounced results. These are attached in Appendix 1 for reasons of completeness.

The median values exhibit several interesting patterns: First of all, the values for the non-failed data sample show only little fluctuations over time for both liquidity-relevant assets and liquidity-relevant liabilities. Therefore, we can interpret the non-failing banks as a benchmark to compare the sample of failed banks to. Additionally, the median values of the liquidity-relevant assets of the non-failing banks lie in a range between 34% and 44%, whereas the median values of the liquidity-relevant liabilities vary between 53% and 55% of the balance sheet total. Assuming that the liquid assets and liabilities are, on average, dominated by short-termed balance sheet positions, there exists a substantial

mismatch between assets and liabilities. This mismatch, however, establishes what is at the heart of the banking business model, namely positive term transformation and the according interest income.

This picture changes completely when looking at the data for failed banks. The figures for both liquidity-relevant assets and liquidity-relevant liabilities differ quite significantly in the level and in their development over time when compared to the non-failed bank sample. The values for liquidity-relevant liabilities decrease more or less monotonically. Starting at roughly 49% of the balance sheet, the values steadily decrease to levels of about 40% when they approach the ultimate default date.

The liquidity-relevant assets for the failed group exhibit a non-monotonic pattern throughout the time series. Starting from values in the range of 45% about five years before the default date, the liquidity-relevant asset ratio starts to increase to maximum values of about 54% two and a half years before default. From this maximum, the values then change their inherent patterns and decrease monotonically to values of about 33%. However, some part of this final decrease in liquidity-relevant assets has to be accounted to industry dynamics, as also the non-failing sample shows a slow decrease in the same periods. Following our interpretation, the pattern observed for the failing sample might be interpreted as a deviation from the traditional term transformation approach – especially when benchmarked with the non-failing bank sample.

Since our sample is strongly biased towards defaults resulting from the recent financial crisis, we include, as a robustness check, an analysis of these results with the defaulting banks of the years prior to 2006. Besides the events of the financial crisis we also want to control our results for different yield curve structures occurring during our analysed time period. This sample amounts to a total of 22 bank defaults, with the last failure dating back to June 2006. Accordingly, the longest history in our data sample of the pre-crisis failures is restricted to 13 quarters.

Figure 4 shows the results of this analysis. The median values show a larger degree of statistically driven variability due to the much smaller sample size. The trend, however, confirms the findings of the overall sample. Adjusting for the lack of previous periods and the higher degree of variability, the developments of both, liquidity-relevant assets and liabilities seem to exhibit a similar pattern in the pre-crisis sample than in the overall sample. Short-term liabilities decrease steadily in the advent of default and short-term assets show the same hump-shaped development as in Figure 3. Summing up, these results suggest that the development of liquidity-relevant balance sheet positions seems to be robust over time and is not biased by specific features of the current financial crisis or a specific interest rate environment.

The analysis above was entirely based on analysing ratios, e.g. individual balance sheet items in relation to the overall balance sheet. To fully understand and interpret the differences in the liquidity structure, we looked at the median growth of liquidity-relevant balance sheet items (assets and liabilities). The detailed analysis can be found in Appendix 2 and Appendix 3 and shows that over the entire sample of failed banks, volatility with regard to individual balance sheet items is much more pronounced than it is for the non-failing banks. Most of the figures, however, circle around zero values for both groups, indicating no relevant change of patterns. Net Other Loans and Leases establish the exception and main driver of the overall development compared with the findings of Figure 5 (median growth of balance sheet total). It becomes obvious that the failed bank sample grows at a higher pace with regard to absolute balance sheet numbers (e.g. driven by Net Other Loans and Leases) than the non-failed banks' balance

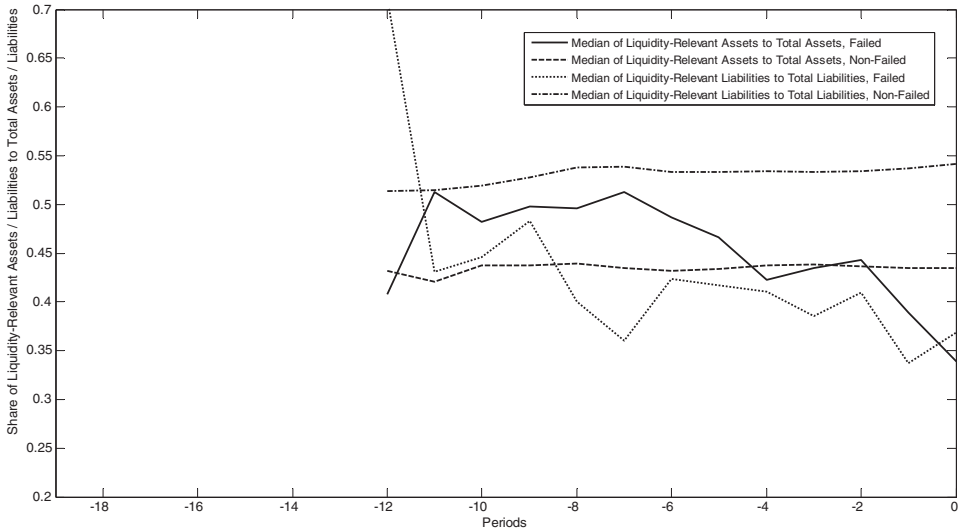


Fig. 4. Median of liquidity-relevant assets/liabilities to total balance sheet size, pre-crisis sample.

This figure presents the median evolution of the liquidity-relevant balance sheet positions for failed banks and non-failed bank separately. The failed banks sample only includes institutions that failed prior to 2007, which we set as the beginning of the recent financial crisis. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered accordingly to reflect the default pattern of failing banks and hence control for any industry-wide developments. The values are calculated in relation to the balance sheet total. Since there were no defaults in years directly preceding the crisis, this sample contains only few observations.

sheets. This pattern appears up to roughly two years before a default occurs. With regard to our relative analysis of the balance sheet items this means that the increase of liquidity-relevant assets of the failed sample is even more severe as the balance sheet total increased at the same time.

To further analyse the decrease of short-term liabilities and the shift in balance sheet positions, we cross-checked for the medians of illiquid balance sheet items to balance sheet totals on the asset and the liability side. It becomes clear that the increase in liquidity-relevant loans and leases in the failed banking group is achieved by a decrease in all other long-term loans and leases (see Appendix 4 and Appendix 5). With regard to the liability side, it is remarkable that about one year before default, long-term time deposits smaller than USD 100,000 increase sharply for the failed banking sample. Furthermore, the large long-term deposits above USD 100,000 increase on the path to default and constantly remain at higher levels for the failed than for the non-failed banks.

Besides the analysis based on median values presented above, the distributions of liquidity-relevant assets and liquidity-relevant liabilities were additionally tested on significant differences between the failing sample and the surviving sample using a two-sample t-test. The results are reported in Appendix 1 and strongly correspond to the findings of Figure 3 and higher differences between the failed and the non-failed sample resulting in higher significance of the tests.

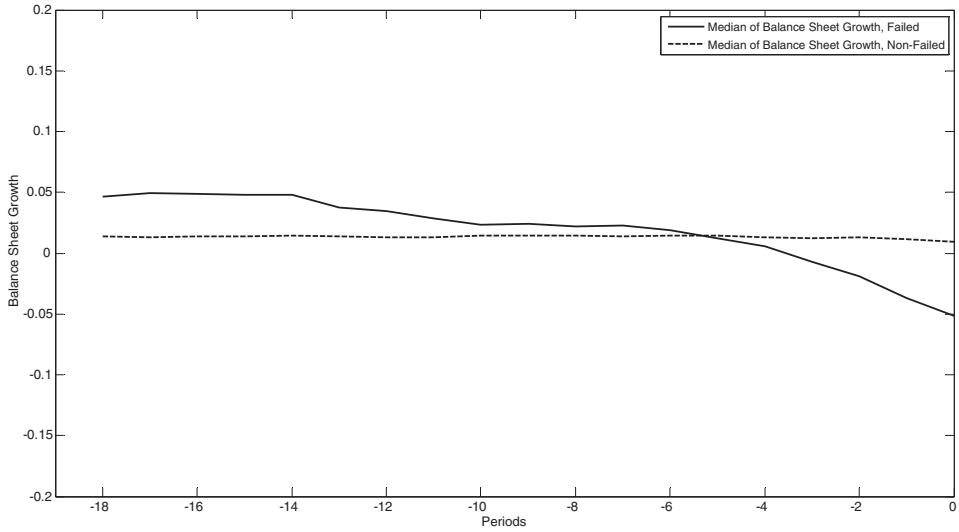


Fig. 5. Median growth of balance sheet total.

This figure presents the median growth of the balance sheet total for the sample of failed banks and the sample of non-failed banks separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered accordingly to reflect the default pattern of failing banks and hence control for any industry-wide developments.

4.2. *Causes for changes in liquidity patterns*

Throughout the previous section we observed diverging patterns regarding the liquidity structure of failed and non-failed banks. Since the alteration does not seem to improve the state of banks, this part of the paper aims to identify the reasons for change in the liquidity positions as undertaken by the failed banks prior to their default. Based on existing literature, we identify two potential motivations that might cause the observed deviations: Window dressing, and a bad client structure.

Regarding window dressing activities, we test for two different hypotheses: First, banks with a more powerful creditors' base might be forced to pursue less aggressive business strategies. In particular we argue that the share of market funding via bonds, as compared to customer deposits, forces a bank to build on a conservative term transforming strategy. This hypothesis is derived from recent work by King and Wen (2011) with regard to the relation between the overall corporate governance structure and managerial risk-taking behaviour. The authors find that the overall governance structure has a significant impact on how managers make decisions on investment policy; in particular strong bondholder governance motivates more low-risk investments. Second, with regard to window dressing activities, we test for the share of money market refinancing in relation to deposits. The reasoning is basically identical to the reasoning for bondholders. There are, however, some obvious differences between bondholders and money market refinancing. We argue that the most important difference is that money market refinancing, due to its short maturity, focuses on the short-term liquidity of the creditor – which is in this case the bank. Bondholders, on the contrary, should focus on the longer-term solvency and soundness of a bank since bonds have, on average, a longer

Table 5

Diff-in-Diff Test on share of bondholders

This table presents the results of the difference-in-differences test on the change in liquidity-relevant assets in the period 19 to 12 quarters before default. The test uses a median-split based on the share of bondholders of banks and a distinction of failed and non-failed banks. The significance of differences in changes of liquidity-relevant assets is tested using a two-sample t-test; the difference in differences is tested using an F-test. The results show whether a different level of bondholders in the refinancing structure induces the changes in the liquidity structure of banks.

Difference t = − 19 to t − 12

	Failed	Non-Failed	
	Change in Share of Liquid Assets		Diff / **Diff-in-Diff**
High Level of Bondholders	0.111	0.002	0.1095***
Low Level of Bondholders	0.031	−0.062	0.0931***
Diff / **Diff-in-diff**	0.0799***	0.0635***	**0.016**

*/**/*** *indicate significance on the 10%/5%/1%-level.*

Table 6

Diff-in-Diff Test on share of money market refinancing

This table presents the results of the difference-in-differences test on the change in liquidity-relevant assets in the period 19 to 12 quarters before default. The test uses a median-split based on the share of money market refinancing of banks and a distinction of failed and non-failed banks. The significance of differences in changes of liquidityrelevant assets is tested using a two-sample t-test; the difference in differences is tested using an F-test. The results show whether a different level of moneymarket refinancing induces the changes in the liquidity structure of banks.

Difference t − 19 to t − 12

	Failed	Non-Failed	
	Change in Share of Liquid Assets		Diff / **Diff-in-Diff**
High Moneymarket Ref.	0.110	−0.011	0.121***
Low Moneymarket Ref.	0.032	−0.043	0.075***
Diff / **Diff-in-diff**	0.078***	0.032***	0.046**

*/**/*** *indicate significance on the 10%/5%/1%-level.*

maturity. In terms of maturity structure, bondholders are subordinated to money market investors and thus care more in terms of governance about the longer-term solvency.

We test these hypotheses using a median split of the failed and the non-failed sample and a difference-in-differences approach. The median split is based on the share of bondholders in Table 5 and based on the share of money market refinancing in Table 6. This results in four subsamples for each of the two splitting factors. According to our findings in Figure 3, we focus on the period four to five years prior to default, which corresponds to the time frame in which the banks most strongly increase their LRA. We employ a difference-in-differences approach to test whether the increase in LRA is significantly different between the high level of bondholders (money market funding

activities) and the low level of bondholders (money market funding activities) groups. The results show that in both, the failed and the non-failed sample, banks with a higher share of bondholders increased the LRA to a significantly greater extent (or decreased less) than the banks with a low share of bondholders. This is in line with expectations if bondholders did in fact foster window dressing activities. The difference-in-differences, however, is not statistically significant, indicating that the impact of a higher share of bondholders is similar for the failed and the non-failed sample. This does not support the hypothesis that bondholders have an impact on changes in LRA, since the effect is only observable in the failed sample and hence, the differences should be more pronounced here. We therefore infer that there is only weak indication for window dressing behavior with regard to bondholders.

The results on money market refinancing are qualitatively similar to the results on bondholders. Regarding the failed sample, the figures on the high and the low money market group are almost identical to the figures with the bondholder split. However, since the difference in the non-failed sample is less pronounced for the money market case, we find a higher and statistically significant difference-in-difference for the case of money market refinancing. Following the outlined argumentation, it makes sense that the observed effect is more pronounced: Since the observed increase in LRA is mostly due to an increase in unsecured, short-term loans, it is reasonable to argue that banks that are strongly financed by short-term oriented money market funds, have a higher incentive to improve the liquidity position of the bank. Regarding bondholders, this effect is less pronounced since bondholders not only focus on the short-term liquidity of banks, but they also focus on low credit standards associated with short-term unsecured loans.

In the next step, we test for a bad client base of banks. The reasoning is that banks that initially have a worse client base will be facing a higher amount of unused commitments that are called in the case of an economic crisis. This could also have happened during the recent crisis, when bad borrowers were forced to draw on their credit lines, either because they needed additional financing or because the existing financing was not extended. Accordingly, in this scenario, a bank with a higher amount of outstanding unused commitments would face a stronger increase in LRA. In this context the shift in its liquidity assets would not be induced by a voluntary immediate management decision but an exogenous event forcing the bank to diverge from the existing liquidity structure. However, the high level of outstanding commitments prior to the documented increase of LRAs was induced by past management. The results on the difference-in-differences test support the hypothesis of unused commitments as a driver of the observed changes in the balance sheet structures: We find that banks with a higher amount of unused commitments face a stronger increase in LRA throughout the observation period in the failed sample as well as in the non-failed sample. We additionally find that this effect is more pronounced for the failed banks, which is in line with the findings of Figure 3.

We also control our empirical findings with regard to different levels of leverage (defined as equity to total assets) and analyse if the individual level of bank leverage has an impact on the observed shift in liquidity patterns. Again, we apply a difference-in-differences approach to test whether the increase in LRA is significantly different between the high-leverage and the low-leverage groups for the same time period as used throughout Tables 5–7.

Table 8 shows the test results for the leverage factor. We find that both, the failing and the non-failing banks increased their LRA less during the observation period, if the banks were more leveraged. The difference-in-differences supports this finding as it is negative

Table 7

Diff-in-Diff Test on unused commitments

This table presents the results of the difference-in-differences test on the change in liquidity-relevant assets in the period 19 to 12 quarters before default. The test uses a median-split based on the unused loan commitments of banks and a distinction of failed and non-failed banks. The significance of differences in changes of liquidity-relevant assets is tested using a two-sample t-test; the difference in differences is tested using an F-test. The results show whether a different level of unused commitments to customers' credit lines induces the changes in the liquidity structure of banks.

Difference t = −19 to t = −12

	Failed	Non-Failed	
	Change in Share of Liquid Assets		Diff / **Diff-in-Diff**
High Unused Commitments	0.109	−0.011	0.12***
Low Unused Commitments	0.032	−0.043	0.075***
Diff / **Diff-in-diff**	0.077***	0.032***	**0.045****

*/**/*** *indicate significance on the 10%/5%/1%-level.*

Table 8

Diff-in-Diff Test on leverage

This table presents the results of the difference-in-differences test on the change in liquidity-relevant assets in the period 19 to 12 quarters before default. The test uses a median-split based on the leverage ratio of banks and a distinction of failed and non-failed banks. The significance of differences in changes of liquidity-relevant assets is tested using a two-sample t-test; the difference in differences is tested using an F-test. The results show whether a different level of leverage induces the changes in the liquidity structure of banks.

Difference t = −19 to t = −12

	Failed	Non-Failed	
	Change in Share of Liquid Assets		Diff / **Diff-in-Diff**
High Leverage	0.029	−0.053	0.082***
Low Leverage	0.112	−0.004	0.116***
Diff / **Diff-in-diff**	−0.083***	−0.049***	**−0.034**

*/**/*** *indicate significance on the 10%/5%/1%-level.*

and not statistically significant. In case of a causal relationship, we would expect to find a more pronounced, positive difference in the failed sample as compared to the non-failed sample. We also controlled for potential lag effects based on past realised losses prior to the liquidity shift as well as regressed past earnings on the corresponding banks liquidity strategy, which also led to now significant results. Thus, the banks' leverage factor can be excluded as a cause for the observed change in liquidity patterns.

Summing up, we conclude that a bad client base forced banks to increase their LRA due to outstanding commitments that were eventually drawn in the course of the crisis. Additionally, also window dressing activities appear to play an important role. We show that the management of banks tries to appear exceptionally liquid towards outside

investors. This is especially true with regard to short-term money market funds, but less so with regard to bondholders. Finally, leverage seems not to be an important factor in this scenario.

4.3. *Impact of liquidity on bank stability*

In a third step, we want to enrich our analysis by showing how liquidity assets and liabilities of banks might be used in assessing bank stability and predicting bank defaults. Therefore, we perform two sets of logistic regressions on our data sample as a follow-up to the previous analyses. Both sets employ bank failure as dependent variable and liquidity-relevant assets and liquidity-relevant liabilities as predictor variables. Additionally, based on existing financial literature we include several control variables (Cole and Gunther, 1995, 1998; Wheelock and Wilson, 2000; Arena, 2008).

Equity serves as a security cushion in case of unfavourable market developments and therefore enhances a bank's ability to absorb shocks and remain adequately capitalised even in distress. Accordingly, equity in relation to total assets (EQA) is assumed to positively affect bank stability. Asset quality affects bank soundness by imposing a high risk of losses for future periods. In this area, three different variables were found to significantly influence bank defaults: loans past due more than 90 days to total assets, non-accruing loans to total assets and total non-performing loans to total assets. As a predictor of future losses, these variables are assumed to negatively affect bank stability. An additional fourth variable controls for effects of the recent financial crisis and is calculated as real estate owned by the financial institution relative to the balance sheet total (ORE). We measure profitability using the net income of banks to balance sheet total (INC). As profitable banks should be more capable of dealing with negative external shocks, a higher net income ratio should decrease the risk of failure. The measures regarding liquidity are investment securities to total assets (SCA) and large certificates of deposits to total assets (LCD). These measures approximate liquid assets and stable liabilities respectively and are hence assumed to foster bank stability. Additionally, we control for unused loan commitments of banks relative to their balance sheet total (UCA). During a period of crisis, contractually binding loan commitments are more likely to be drawn and hence, a higher degree of unused commitments makes a bank more vulnerable (Campello *et al*., 2010). Based on recent research of Lepetit *et al*. (2008), we also control for the impact of income diversification using the share of non-interest income to total income (DIV). Finally, we control for any size effects using the natural logarithm of the balance sheet total (SIZ) and different bank types using a dummy variable for commercial banks and savings banks (TYP).

Before conducting the logistic regressions, we test all variables on multi-colinearity using the variance inflation factor. The results suggest high colinearity among all variables on loan quality. Consequently, we use principle factor analysis to combine the information in one variable. The resulting variable (BAD) still accounts for 85.5% of the total variance. The new set of variables is no longer subject to colinearity.

We conduct the first analysis as pooled logistic regression using all available cases and all periods (Table 9). The analysis of the constrained model includes only the control variables; the unconstrained model includes also the liquidity-relevant assets and liabilities. For both, the constrained and the unconstrained model, all variables except for income diversification proof to significantly affect bank default. This finding is interesting in the light of the large body of current literature dealing with this topic that finds a positive influence of income diversification on bank stability, e.g. Lepetit

Table 9

Pooled logistic regression

This table presents the results of the logistic regression using liquidity-relevant assets (LRA) and liquidity-relevant liabilities (LRL) on failure of banking institutions. As control variables we employ the log of the balance sheet total (SIZ), a dummy variable indicating the bank type (TYP), a proxy of the bank's income diversification (DIV), unused commitments in relation to total assets (UCA), equity to balance sheet total (EQA), real estate owned to balance sheet total (ORE), securities to balance sheet total (SCA), large certificates of deposits to balance sheet total (LCD), net income to total assets (INC) and one variable reflecting the amount of bad loans in relation to balance sheet total (BAD). We conduct a logistic regression for the unconstrained model, which includes all of the variables and for the constrained model which only employs the control variables, excluding LRA and LRL. The likelihoodratio test indicates whether the improvement of the model fit by including LRA and LRL is statistically significant

Dependent:	Failure			
	Unconstrained Model		Constrained Model	
Independent	Exp(Coeff)	Coeff / Std. Err	ExpCoeff	Coeff / Std. Err.
LRA	6.66	1.896***		
		[0.521]		
LRL	0.09	−2.417***		
		[0.556]		
SIZ	1.14	0.135***	1.13	0.121**
		[0.0499]		[0.0506]
TYP	1.41	0.344	1.53	0.428**
		[0.249]		[0.172]
UCA	22.85	3.129***	37.94	3.636***
		[0.686]		[0.677]
EQA	0.00	−9.607***	0.00	−7.622***
		[1.688]		[1.649]
BAD	2.97	1.090***	3.20	1.164***
		[0.0909]		[0.0891]
ORE	0.00	−12.17	0.00	−11.37
		[12.14]		[12.02]
SCA	0.07	−2.693***	0.06	−2.857***
		[0.693]		[0.704]
LCD	83.43	4.424***	269.89	5.598***
		[0.746]		[0.711]
INC	28.50	3.350***	11.20	2.416***
		[0.748]		[0.721]
DIV	0.99	−0.0111	1.00	−0.00952
		[0.0149]		[0.0144]
Observations	10.966		10.966	
Prob > Chi2	0.000		0.000	
McFadden's Adj. R-Squared	0.222		0.213	
Likelihood-ratio Test				
LR Chi2(2)	23.81			
Prob > Chi2	0.000			

* *indicates significance on the 10%-level.*

** *indicates significance on the 5%-level.*

*** *indicates significance on the 1%-level.*

et al. (2008) and Demirgüç-Kunt and Huizinga (2010). We in contrast find that income diversification does not impact the likelihood of bank failure in any direction. The level of net income, however, does significantly affect bank stability. Regarding the other significant control variables, a bank is more likely to fail if it is larger, has more unused commitments outstanding, less equity and more non-performing loans. These findings are all in concordance with our expectations and the results of previous studies. A higher degree of liquid securities increases bank stability while large deposits decrease stability. This is also in accordance with expectations since trading securities are more easily sold and turned into cash in case of distress. Our results suggest a higher risk of default for savings banks as compared to commercial banks. The constrained model explains 21.3% of the overall variance, based on the adjusted McFadden's R-squared, which seems realistic as most of these measures were designed to predict bank default in the short run.

The unconstrained model incorporates liquidity-relevant assets and short-term liabilities as additional predictors. Both variables significantly contribute to the performance of the model. The adjusted McFadden's R-squared of the model is 22.2%, which suggests an improvement in predictive power even when adjusting for the additional variables included. To test this improvement on statistical significance, we used the likelihood-ratio test comparing the unconstrained and the constrained model. The null hypothesis has to be rejected at the 0.1% significance level and, hence, omitting LRA and LRL as predictors significantly decreases the model fit.

The coefficients of the analysis suggest that a higher portion of liquidity-relevant assets increase the likelihood of default and increasing liquidity-relevant liabilities enhance bank stability. This finding is in contrast to the common understanding of liquidity deficits as a major driver of bank default. To understand these results, it is important to keep in mind that we employed the analysis on a medium to long-term horizon as compared to most other studies. Consequently, it seems that, even though liquidity is unarguably important for the survival of a financial institution in the very short run, keeping the balance sheet more liquid in terms of matching maturities of the assets and the liabilities, impacts bank stability to the negative in the medium to long-run. These findings can be linked to the displayed positive correlation between profitability and bank stability: in a normal interest environment liquid assets yield lower income as compared to long-term assets.

To further analyse this finding, we conduct a second set of logistic regressions (Table 10). This time, the failed sample is split up according to remaining quarters to default and each of these subsamples is compared to all non-failing cases and periods.[2] We again, conduct the analysis for the constrained model, using only the control variables, and the unconstrained model, which also includes liquidity-relevant assets and liquidity-relevant liabilities. The results of the control variables are not reported, but the main aspects for the control variables match with the results from the pooled regression. In both cases, failure is the dependent variable.

The results of this analysis match very well with the findings of Figure 3. The variance explained in the first half of the sample is relatively low. This is probably due to the fact that the control variables focus on short-term default and hence do a bad job predicting default up to five years in advance. However, it is worthwhile noting that

[2] All non-failing cases and periods are included since there is no single quarter, meaningful corresponding to the default date of the failing banks.

Table 10

Logistic regression, failed institutions by quarter

This table presents the results of logistic regressions with liquidity-relevant assets (LRA), liquidity-relevant liabilities (LRL) and a set of control variables as predictors and failure as dependent variable. We conduct the analysis based on quarters-to-default of the failed sample. In every quarter, only the respective values of the failed samples are included. Quarter t = −19 corresponds to the report five years prior to default. Quarter t = 0 represents the last available report prior to default. For the non-failing sample, the data is weighted matching the default pattern of the failing sample. The McFadden's adjusted r-squared are reported for the constrained model, which includes only control variables and the unconstrained model including also LRA and LRL as predictors. Additionally, the results of the likelihood-ratio test of the constrained and unconstrained model are reported.

Dependent:	Failure								
	Exp(Coeff)		z-Value			McFadden's Adj. R-Squared		Likelihood-Ratio Test	
Independent	LRA	LRL	LRA	LRL	Prob > Chi2	Unconstrained	Constrained	LR Chi2(2)	Prob > Chi2
t = −19	4.93	0.25	4.23***	−3.34***	0.00	0.054	0.050	22.98	0.00
t = −18	6.38	0.18	5.05***	−4.22***	0.00	0.061	0.054	34.11	0.00
t = −17	8.61	0.19	6.06***	−4.14***	0.00	0.074	0.066	42.64	0.00
t = −16	12.03	0.11	7.28***	−5.68***	0.00	0.091	0.077	66.91	0.00
t = −15	11.23	0.09	7.14***	−6.11***	0.00	0.100	0.086	69.39	0.00
t = −14	14.00	0.08	8.01***	−6.34***	0.00	0.109	0.092	81.90	0.00
t = −13	15.18	0.09	8.30***	−6.22***	0.00	0.108	0.091	84.44	0.00
t = −12	16.89	0.07	8.81***	−7.07***	0.00	0.111	0.090	100.48	0.00
t = −11	14.47	0.06	8.30***	−7.34***	0.00	0.113	0.093	97.05	0.00
t = −10	12.47	0.07	7.73***	−6.96***	0.00	0.107	0.089	85.77	0.00
t = −9	8.95	0.07	6.64***	−6.87***	0.00	0.106	0.091	73.45	0.00
t = −8	7.96	0.05	6.22***	−7.69***	0.00	0.106	0.090	79.77	0.00
t = −7	7.26	0.04	5.89***	−8.28***	0.00	0.111	0.094	85.25	0.00
t = −6	5.16	0.04	4.69***	−7.69***	0.00	0.124	0.111	68.11	0.00
t = −5	2.89	0.05	2.84***	−7.21***	0.00	0.157	0.147	53.16	0.00
t = −4	2.10	0.05	1.87*	−6.72***	0.00	0.214	0.206	44.91	0.00
t = −3	2.57	0.04	2.41**	−7.7***	0.00	0.275	0.265	49.25	0.00
t = −2	3.70	0.03	3.87***	−9.29***	0.00	0.290	0.254	175.32	0.00
t = −1	1.98	0.19	1.41	−3.28***	0.00	0.555	0.553	13.13	0.00
t = 0	1.99	0.57	1.24	−0.92	0.00	0.709	0.707	10.13	0.01

* *indicates significance on the 10%-level.*

** *indicates significance on the 5%-level.*

*** *indicates significance on the 1%-level.*

the small amount of explained variance during these periods is strongly influenced by liquidity-relevant assets and liquidity-relevant liabilities. These structural differences seem to significantly contribute to the model fit even in the very long run. This fact is supported by the 0.1%-significance of liquidity-relevant liabilities in all of these periods and also the likelihood-ratio test which supports the assumption of significant model improvement by the two predictor variables for all periods.

The odds ratio of the liquidity-relevant liabilities remains at relatively constant levels for most of the observation period. Hence, liquidity-relevant liabilities seem to impact the likelihood of failure in a structural sense but do not so much depend on time to default. The impact of liquidity-relevant assets on default probability, however, critically depends on the remaining periods to default. Here, the odds ratio mimics the hump-shaped development of Figure 3. A higher (or lower) difference between the failed and the non-failed sample increases (decreases) the probability of correctly identifying failing institutions. Accordingly, the odds ratio, or the increase in probability of default due to an incremental increase in the independent variable, ceteris paribus, is larger if the independent variable separates failures from non-failures more sharply.

As with the pooled logistic regression, the range of values of both odds ratios suggests increasing fragility with lower term transformation for all significant periods. The comparison of the constrained and the unconstrained model shows that our term transformation variables mainly improve the model in the medium term, namely about three to four years before default. This again corresponds to the finding of Figure 3, which shows that the dispersion between failed and non-failed liquidity-relevant assets is significant in this period. In particular, the results of the likelihood-ratio test support the findings of the comparison of model fit. All periods show a significant increase in prediction power due to liquidity-relevant assets and liquidity-relevant liabilities.

5. Discussion

From the angle of a liquidity-driven perspective, our empirical results suggest that there are distinctive differences between failed and non-failed banks. One of our key findings in this context is that failed banks deviate from their traditional business model and do not continue to perform their original (positive) term transformation function culminating about 3 years before default. During this time period, liquidity-relevant liabilities and liquidity-relevant assets of the failed banks even suggest negative term transformation. This process is largely driven by a shift from long-term loans towards short-term loans and leads to an increase in liquidity. However, this pattern is not persistent until default but is reversed in the last six quarters prior to the default situation. At the same time non-failed banks maintain their original (positive) term transformation and show low volatility in their capital structure.

This finding is of particular interest, since term transformation is generally viewed as a bank's (market) risk factor. Yet, in our sample banks actually reducing their term transformation are more likely to default in the intermediate future (2–3 years).

Analysing the reasons leading to the observed shift in liquidity structure we control for window dressing and a bank's bad client structure. Window dressing proved to be one of the reasons driving the change in liquidity patterns, which is particularly true for money market activities. Banks with a great exposure towards money markets aim to ally their investors with a liquid asset base. This behaviour is also reasonable from a governance perspective of money markets investors, since they are among the

first to withdraw their money and are therefore particularly concerned about liquidity positions.

As a rather exogenous driven cause, we observed that a bad client base in terms of unused commitments drawn by clients leads to an increase in LRA. We interpret this induced increase as a situation in which banks clients experience financial difficulties and thus have to rely on their liquidity cushions. Typically prior to a company's default all existing credit lines are drawn to the maximum. Even though banks cannot avoid these new credit positions, they are the result of former management decisions and banks risk awareness.

In this context we also find no empirical prove that leverage ratios are a significant factor driving the documented change in liquidity patterns. A classical moral hazard argumentation is therefore not supported by our results.

About two and a half years before default, counteractions are initiated with the goal of returning to the original term transforming business model. This is tried to be achieved by reducing the risky portion of loans on the balance sheet. During this turnaround process failed banks are not as well positioned as their counterparts with steady business models to absorb potential shocks to the banking business (as experienced throughout the financial crisis). The last quarters before default thus could be interpreted as being dominated by futile counteractions like build-up of cash positions.

The documented shift in liquidity patterns is found for the US banking industry, which is organised as a market-oriented financial intermediation system. The question arising in this context is to what extent our findings also hold for a balance sheet-oriented system. In the following we discuss this issue with regard to the two dominating causes for changes in liquidity patterns: bad client base and window dressing in connection with money market financing.

Based on a set of 4,828 Continental European and 9,532 US banks respectively we outline in Table 11 in detail how this system difference leads to heterogeneous balance sheet structures:[3] Primarily, we observe that European banks allocate more assets to their credit book (49.7% versus 35.5%), are less dependent on money market funding activities as compared to their US peers (16.1% versus 23.0%) but rely to a greater extent on deposits (49.8% versus 43.3%) as a refinancing source. US banks in turn allocate more capital to their trading book (47.8% versus 41.7%). We now argue that *total loans net* incorporate longer maturity structures on average (and/or are less tradable) as compared to *total other earning assets* and that this difference is not neutralised by significant shorter maturity structures on the liabilities side of US banks. Therefore, we conclude that term transformation is more accentuated for Continental European than for US banks. Additionally, the Continental European banking system is more oriented towards relationship banking, which results in stable and long-term oriented lending relationships (Ongena and Smith, 2001). In this context banks are less likely to terminate a lending relationship, which also positively impacts the access to credit for borrowers (Boot, 2000). Relationship banks also provide liquidity in deteriorating financial situations of individual firms (Elsas and Krahnen, 1998).

[3] Since Bankscope data is available for both Continental European and US banks, we use this database in order to guarantee comparability between the two regions. We tried to match Bankscope data for Continental Europe with the US FDIC database applied in this paper, but retrieved misleading results due to different definitions of individual balance sheet positions.

Table 11

Continental European and US bank balance sheet structure (2009)

This table presents the mean relative values of Continental European and US-American balance sheet structures for the financial year 2009. The Continental European sample consists of 4829 banks, whereas the US incorporates 9523 banks. All figures are derived from Bankscope in order to ensure data comparability between the different regions.

Assets (2009, mean values in %)	**Cont. Europe** *(N=4828 Banks)*		**U.S. American** *(N=9523 Banks)*	
Cash & Other Non-Earning Assets	7.7%		*15.8%*	
Total Other Earning Assets	41.7%		*47.8%*	
Equity Investments		*1.8%*		*0.4%*
Other Investments		*0.7%*		*0.8%*
Total Securities		*20.1%*		*14.0%*
Government Securities		*4.6%*		*2.9%*
Due From Banks		*14.5%*		*29.7%*
Total Loans Net	49.7%		35.5%	
Loans to other Corporate		*21.5%*		*3.4%*
Other Loans		*18.1%*		*2.2%*
Mortgages		*10.0%*		*29.9%*
Total Fixed Assets	1.0%		1.0%	
Liabilities (2009, mean values in %)	**Cont. Europe** *(N=4828 Banks)*		**U.S. American** *(N=9523 Banks)*	
Total Deposits	49.8%		43.3%	
Customer & Other Deposits		*31.9%*		*42.7%*
Bank Deposits		*18.0%*		*0.5%*
Total Money Market Funding	16.1%		23.0%	
Securities Loaned		*0.0%*		*7.8%*
Other Securities		*5.8%*		*14.5%*
Other Negotiable Instruments		*10.3%*		*0.7%*
Total Other Funding	27.4%		22.9%	
Total Equity	6.7%		10.8%	

As one of the dominating causes for changes in liquidity patterns we detected a bad client's base as the observed liquidity shift could be linked to bad borrowers being forced to draw down their existing credit lines. If we assess this result against the background of different financial intermediation systems, we expect that this finding is not limited to the marketed-oriented banking scheme, but should also hold for the balance-oriented one: Unused commitments being drawn by clients experiencing refinancing problems is not a specific feature of the US banking industry, but also holds for European banks (see also Elsas and Krahnen, 1998).

Besides a bad client base we also found empirical proof that window dressing in combination with money market financing is one of the main explanations for the documented liquidity shift. If we now link this finding with the observed structural differences between Continental Europe and the US, we acknowledge that money markets are far more important for US banks and that relationship banking should have a stronger impact on the composition of the asset side in the case of European banks as their flexibility to manage the asset side in particular with regard to loans is limited. In other

words, based on window dressing activities, we expect the shift in liquidity positions to be more accentuated in a market-oriented than in a balance sheet-oriented system.

Turning our attention towards existing literature on this matter, we find in Bechmann and Raaballe (2010) an interesting example opposing to our results: The authors show that in the case of Denmark – as an example for a balance sheet-oriented financial intermediation system – the banking sector in total followed a policy of high term transformation before the recent financial crisis in which several banks had to be bailed out by the Danish government. Yet, we have to consider that during the years prior to the financial crisis the Danish banking system carried country-specific characteristics (e.g. deposit deficit against loans of 20%, extreme growth of long-term lending activities fuelled by short-term deposits of foreign banks). With the intensifying financial crisis the deposits of foreign banks were not prolonged and Danish banks experienced refinancing difficulties and, accordingly, suffered from their high levels of term transformation. Assuming that this increase of term transformation particularly also holds for failed banks, we would expect that a bad client's base leads to a shift in liquidity patterns. However, the Danish banking crisis was mainly driven by liquidity pressure on the liability side. Thus, the potential effect of our second identified cause (window dressing) should be more accentuated. An increase in short-term (foreign) deposit funding in the case of Danish banks should also lead to an according adjustment of the asset side (e.g. less loans and more short-term assets). In such an environment we would expect that changes in liquidity patterns might occur as documented for failed banks in the US. Yet, Bechmann and Raaballe (2010) observe that even though the Danish banking system experienced a massive inflow of short-term capital, it did not adjust on average (including failed and non failed banks) its asset-side as lending activities were increased. We attribute this finding to the dominance of relationship banking in Denmark.

6. Conclusion

In this paper we analyse the liquidity dynamics of bank defaults. Our approach employs a data sample that covers all FDIC-ruled banks and financial institutions within the US banking industry over a period of nine and a half years and, most importantly, 329 bank defaults. Using this data, we observe that failing and surviving banks manage their liquidity positions differently and detect the following main patterns:

First, defaulted banks drift away from the traditional business model of banks by abandoning a (positive) term transformation, culminating about three years before default. This shift is driven by an increase in liquidity-relevant assets (e.g. short-term loans). Second, we document that this liquidity shift is induced by window dressing activities towards bondholders and money market investors as well as a bad client base. Third, not income diversification drives the insolvency risk of banks, but endogenous changes in the capital structure. We show that liquidity-relevant asset and liability positions have a significant impact on default patterns.

Appendices

Appendix 1. *Mean and median of liquidity-relevant assets and liabilities to total balance sheet*

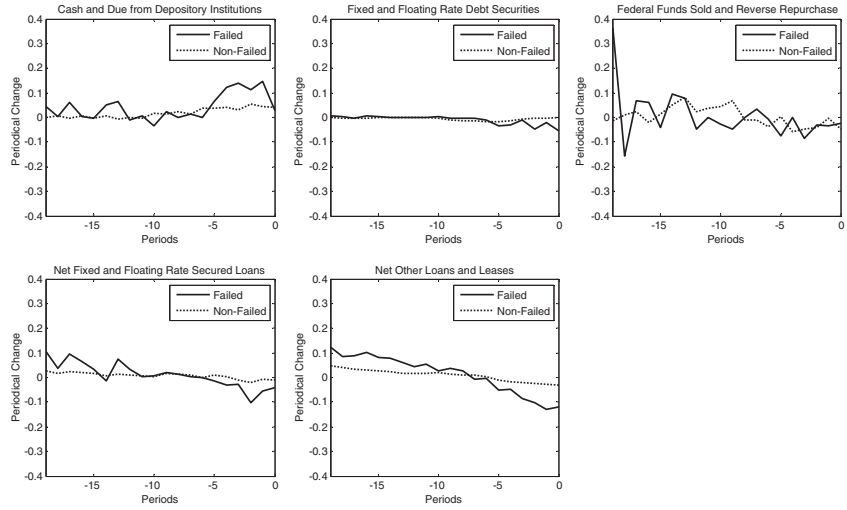
This table presents the median and mean values of the liquidity-relevant asset and liabilities positions relative to the balance sheet total. The sample covers balance sheet information reported to the FDIC for the period 2001 to H1-2010 on a quarterly basis. Values are reported for failed (F) and non-failed (NF) banks separately. For the failed banks, t = 0 corresponds to the last available data before default. Non-failed banks are ordered to reflect the default pattern of failing banks and hence control for any industry-wide developments. Significance levels for the differences between failed and non-failed samples are reported as results of a two-sample t-test.

Share of Balance Sheet Total

	Median						Mean						Significance of Difference between Non-Failed and Failed Samples	
	Liquidity-Relevant Assets			Liquidity-Relevant Liabilities			Liquidity-Relevant Assets			Liquidity-Relevant Liabilities				
	NF	F	NF-F	NF	F	NF-F	NF	F	NF-F	NF	F	NF-F	Assets	Liabilities
t = −19	44.0%	45.5%	−1.4%	53.7%	49.1%	4.6%	43.7%	44.0%	−0.3%	53.0%	48.1%	4.9%		***
t = −18	44.5%	46.1%	−1.7%	54.8%	46.7%	8.1%	44.2%	44.8%	−0.5%	53.8%	47.4%	6.4%		***
t = −17	44.1%	49.5%	−5.4%	54.0%	48.4%	5.6%	43.8%	46.1%	−2.2%	53.0%	47.6%	5.4%	*	***
t = −16	42.8%	51.2%	−8.4%	53.2%	46.4%	6.8%	42.9%	47.5%	−4.6%	52.5%	46.2%	6.2%	***	***
t = −15	42.7%	52.3%	−9.6%	52.2%	46.8%	5.4%	42.8%	47.3%	−4.6%	51.4%	45.8%	5.6%	***	***
t = −14	43.7%	52.5%	−8.9%	53.5%	45.9%	7.5%	43.5%	48.1%	−4.6%	52.5%	45.5%	7.0%	***	***
t = −13	43.4%	53.4%	−10.0%	53.5%	46.8%	6.7%	43.2%	48.1%	−4.9%	52.4%	45.9%	6.6%	***	***
t = −12	41.9%	54.0%	−12.2%	53.3%	45.1%	8.2%	42.0%	48.4%	−6.4%	52.2%	44.8%	7.4%	***	***
t = −11	41.5%	52.0%	−10.4%	52.4%	44.8%	7.6%	41.7%	47.8%	−6.1%	51.4%	44.3%	7.1%	***	***
t = −10	41.8%	51.3%	−9.5%	53.5%	44.5%	9.0%	41.7%	46.8%	−5.1%	52.1%	44.7%	7.5%	***	***
t = −9	40.1%	48.2%	−8.1%	53.0%	43.9%	9.0%	40.5%	45.6%	−5.1%	51.7%	44.2%	7.5%	***	***
t = −8	37.6%	47.3%	−9.7%	53.7%	43.5%	10.3%	38.3%	44.3%	−6.0%	52.4%	43.7%	8.7%	***	***
t = −7	36.4%	44.5%	−8.0%	52.5%	43.9%	8.7%	37.4%	43.0%	−5.6%	51.3%	43.2%	8.1%	***	***
t = −6	35.1%	41.4%	−6.2%	52.8%	43.1%	9.8%	36.3%	41.2%	−4.9%	51.6%	43.3%	8.3%	***	***
t = −5	35.1%	38.7%	−3.6%	52.2%	41.2%	11.0%	36.3%	38.7%	−2.5%	51.1%	42.8%	8.3%	**	***
t = −4	33.7%	36.1%	−2.4%	53.0%	40.8%	12.2%	35.3%	37.0%	−1.8%	51.9%	42.3%	9.7%	*	***
t = −3	33.5%	35.8%	−2.3%	53.3%	40.2%	13.2%	35.0%	35.8%	−0.8%	52.3%	41.2%	11.0%		***
t = −2	33.7%	33.3%	0.4%	54.8%	39.8%	15.0%	35.4%	34.8%	−0.5%	53.4%	41.4%	12.0%		***
t = −1	34.4%	32.9%	1.5%	54.2%	39.3%	14.9%	35.8%	33.8%	−2.0%	53.0%	40.8%	12.2%	**	***
t = 0	33.8%	31.9%	1.8%	54.6%	40.2%	14.4%	35.1%	33.0%	−2.1%	53.4%	41.4%	12.0%	**	***

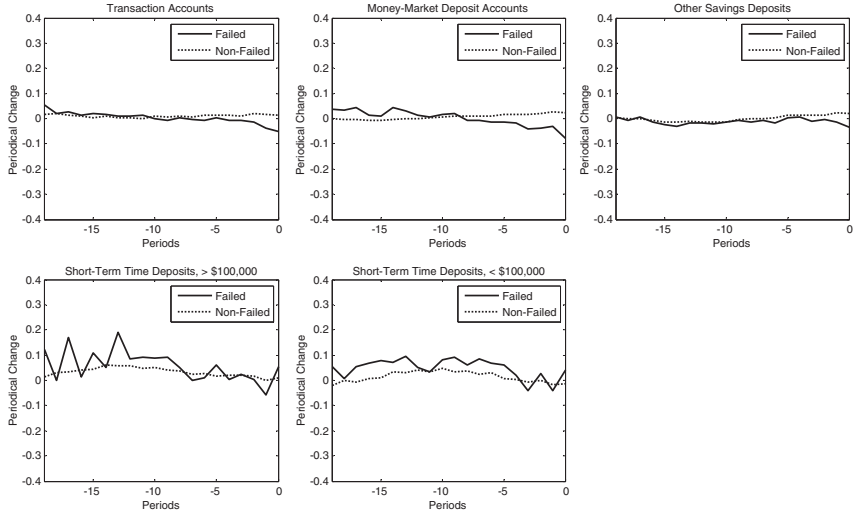
* *indicates significant group differences on the 10%-level.*
** *indicates significant group differences on the 5%-level.*
*** *indicates significant group differences on the1%-level.*

Appendix 2. *Median growth of liquidity-relevant balance sheet items, asset-side*



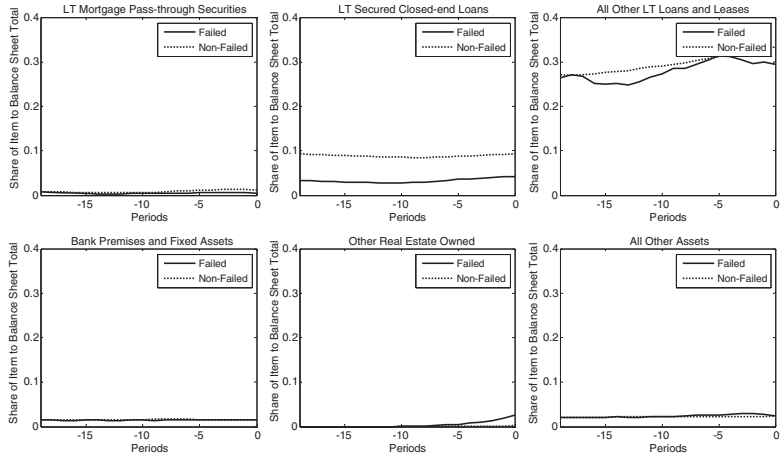
This figure presents the median growth of the most important liquidity-relevant balance sheet positions of the assetside. Values are reported for the sample of failed banks and the sample of non-failed banks separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered to reflect the default pattern of failing banks.

Appendix 3. *Median growth of liquidity-relevant balance sheet items, liability-side*



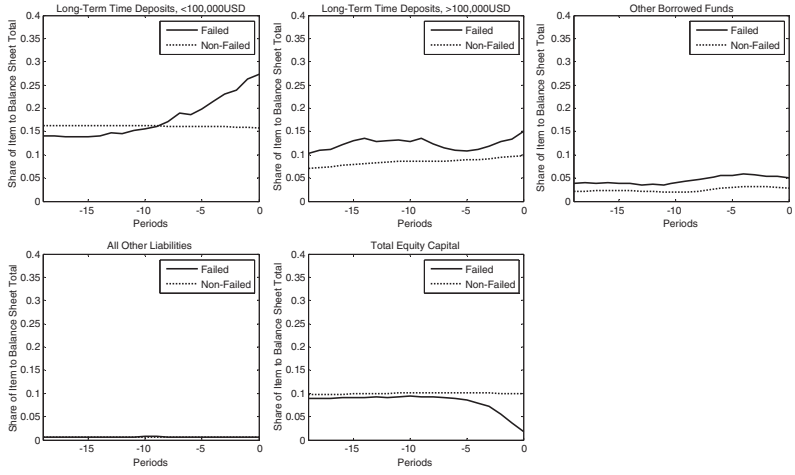
This figure presents the median growth of the most important liquidity-relevant balance sheet positions of the liability-side. Values are reported for the sample of failed banks and the sample of non-failed banks separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered to reflect the default pattern of failing banks.

Appendix 4. *Median of illiquid balance sheet items to balance sheet total, asset-side*



This figure presents the median evolution of the illiquid balance sheet positions on the asset-side for failed banks and non-failed bank separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered to reflect the default pattern of failing banks. Any illiquid asset positions with a median of zero in all periods are not included in the figure. All values are calculated in relation to the balance sheet total.

Appendix 5. *Median of illiquid balance sheet items to balance sheet total, liability-side*



This figure presents the median evolution of the illiquid balance sheet positions on the liabilities-side for failed banks and non-failed bank separately. For the failed banks, period 0 corresponds to the last available data before default. Non-failed banks are ordered to reflect the default pattern of failing banks. Any illiquid liability positions with a median of zero in all periods are not included in the figure. All values are calculated in relation to the balance sheet total.

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