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Dorothee Holl* and Andrea Schertler+

Abstract

For their short-term payment obligations, savings banks hold substantially more liquid assets than the liquidity regulation requires. This paper investigates whether sight deposits, an important funding source for savings banks, help in explaining liquid asset holdings in excess of regulatory requirements. We analyze whether savings banks transform sight deposits in illiquid assets less intensively than is permitted because (i) the liquidity regulation underestimates actual withdrawal rates (underestimation effect) and/or (ii) savings banks are subject to limits in their lending to non-banks that they do not offset by, for instance, medium-term interbank lending or fixed asset holdings (lending effect). In our sample, we do not find the underestimation effect to be applicable as actual deposit withdrawal rates are in most cases lower than the regulatorily specified rate. However, we find the lending effect to be at work: Savings banks with low shares of loans to non-banks do not transform sight deposits into illiquid assets as intensively as savings banks with high shares of non-bank loans. Our analysis does not only show that liquid assets positively depend on sight deposits, but also shines a light on how bank size and the individual bank's position in the interbank market affect liquid assets.

***Keywords**:* liquid assets, sight deposits, prudential liquidity regulation

JEL-Classification: G21

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Non-technical summary

In Germany, the Regulation on the Liquidity of Institutions (formerly Principle II) requires banks to have a liquidity ratio which is at least equal to one. This ratio is calculated by dividing regulatorily specified liquid assets that are available within one month by short-term payment obligations that are callable within this period. Savings banks have almost three times as many liquid assets available for their payment obligations than the regulator requires. This paper investigates whether sight deposits, which are not only factored into the payment obligations at 10% but which are also an important funding source for savings banks, contribute to liquid asset holdings in excess of the regulatory requirements.

We investigate two effects which may induce savings banks to hold more liquid assets for each unit of sight deposits than is regulatorily required with the result that they would not transform sight deposits into illiquid assets as intensively as the regulator permits. The first effect, which we will call the underestimation effect, occurs when the regulator underestimates the likelihood of deposit withdrawals and when liquidity shortages are expensive. The second effect, which we will call the lending effect, occurs when savings banks are subject to limits in their lending to non-banks which they do not offset through investments in other illiquid assets, such as medium-term interbank lending and/or securities held to maturity.

On the basis of bank reports for 2000-2006 and taking into account that banks determine their assets and payment obligations simultaneously, we find that savings banks hold far more regulatory liquid assets for each unit of sight deposits than are regulatorily required. Our findings produce no evidence of the underestimation effect: The regulatorily specified withdrawal rate of sight deposits of 10% can be considered as a conservative measure for actual deposit withdrawal rates in our sample. Our findings suggest, however, that a lending effect is at work: Savings banks with low lending to non-banks transform sight deposits less intensively in illiquid assets than savings banks with high non-bank lending. This finding suggests that it is unprofitable for savings banks with low non-bank lending to achieve the same degree of transformation as their counterparts engaged in high non-bank lending. Principally, savings banks with low lending to non-banks could achieve a similar degree of transformation by granting medium-term interbank loans and/or holding securities to maturity.

While our analysis is primarily focused on how regulatory liquid assets depend upon sight deposits, it also provides information on how these assets vary according to bank size and the individual bank's position in the interbank market, both of which we find to be inversely related to liquid assets. Overall, our results indicate that there is no single factor determining the amount of regulatory liquid assets. Instead, regulatory liquid assets are determined by a multiplicity of factors, some of which should be the subject of further research.

Nicht-technische Zusammenfassung

Die in Deutschland geltende Liquiditätsverordnung (ehemals Grundsatz II) fordert die monatliche Meldung einer Liquiditätskennzahl, die mindestens eins betragen muss. Diese Kennzahl ergibt sich aus dem Verhältnis der innerhalb des nächsten Monats verfügbaren Zahlungsmittel einer Bank und ihren in diesem Zeitraum abrufbaren Zahlungsverpflichtungen. Sparkassen verfügen über fast dreimal so viel Zahlungsmittel, wie sie für ihre Zahlungsverpflichtungen laut der Liquiditätsverordnung halten müssen. Die vorliegende Forschungsarbeit untersucht, ob Sichteinlagen, die mit 10% in die abrufbaren Zahlungsverpflichtungen eingehen, und eine wesentliche Finanzierungsquelle für Sparkassen darstellen, zu dem hohen Bestand an Zahlungsmitteln beitragen.

Diese Arbeit untersucht zwei Effekte, die Sparkassen dazu bringen können, mehr Zahlungsmittel pro Einheit Sichteinlage zu halten als regulatorisch gefordert, so dass Sichteinlagen weniger zur Finanzierung von illiquiden Aktiva verwendet werden als die Liquiditätsregulierung erlaubt. Der erste Effekt, den wir als Unterschätzungseffekt bezeichnen, tritt auf, wenn die regulatorisch spezifizierte Marke der Einlagenabzüge die tatsächlichen Abzüge unterschätzt. Der zweite Effekt, den wir als Krediteffekt bezeichnen, tritt auf, wenn Sparkassen Grenzen bei der Kreditvergabe an Nichtbanken ausgesetzt sind, die sie nicht durch Investitionen in andere illiquide Aktiva, z.B. mittelfristige Interbankkredite und im Anlagebuch bilanzierte Wertpapiere, kompensieren.

Die vorliegende Arbeit basiert auf Daten des Meldewesens von 2000 bis 2006 und berücksichtigt, dass Banken ihre Aktiva und Zahlungsverpflichtungen gleichzeitig festlegen. Die Ergebnisse belegen, dass Sparkassen für jede Einheit an Sichteinlagen über wesentlich mehr Zahlungsmittel verfügen als gemäß der gegenwärtigen Liquiditätsregulierung erforderlich wäre. Wir finden keine Evidenz für einen Unterschätzungseffekt: der Vergleich der tatsächlichen Einlagenabzüge mit der regulatorisch spezifizierten Marke von 10 % deutet an, dass die regulatorische Marke in dem von uns verwendeten Datensatz als konservativ zu bezeichnen ist. Wir finden jedoch Hinweise auf das Wirken eines Krediteffekts: Sparkassen mit wenigen Krediten an Nichtbanken transformieren Sichteinlagen weniger intensiv in illiquide Aktiva als Sparkassen mit vielen Nichtbankkrediten. Generell könnten jedoch auch Sparkassen mit wenigen Krediten an Nichtbanken einen ähnlichen Transformationsgrad erzielen, in dem sie z.B. mittelfristige Interbankkredite vergeben oder im Anlagebuch bilanzierte Wertpapiere halten. Dies scheint jedoch für sie nicht profitabel zu sein.

Auch wenn der Fokus unserer Arbeit auf der Rolle von Sichteinlagen liegt, gibt sie zudem wertvolle Hinweise, welche anderen bankspezifischen Faktoren das Halten von Zahlungsmitteln beeinflusst. Unsere Ergebnisse zeigen, dass große Sparkassen bzw. Sparkassen mit vielen Interbankverbindungen weniger Zahlungsmittel halten als kleine Sparkassen bzw. Sparkassen mit wenigen Verbindungen. Die Höhe der Zahlungsmittel lässt sich somit nicht durch einen einzelnen Faktor, sondern vielmehr durch eine Vielzahl bankspezifischer Faktoren erklären, von denen einige Untersuchungsgegenstand künftiger Forschungsarbeiten darstellen sollten.

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1 Introduction

In Germany, the Regulation on the Liquidity of Institutions (*Liquiditätsverordnung*) and its predecessor Principle II (*Grundsatz II*) require banks to have regulatorily specified liquid assets at least equal to their regulatorily specified short-term payment obligations. Table 1 shows that savings banks have, unlike big banks and state banks, almost three times as much liquid assets for their payment obligations than the regulator requires. This paper investigates whether sight deposits, which are not only factored into the payment obligations with 10% but which are also an important funding source for savings banks but less so for big banks (Memmel and Schertler 2008), contribute to the high amounts of savings banks' liquid assets. They do so when transforming sight deposits into illiquid assets at the degree permitted by the liquidity regulation is unprofitable for savings banks. The regulator permits banks with sufficient repayments from loans to use all their sight deposits to finance illiquid assets, since regulatory liquid assets also contain repayments from loans and advances maturing within the next month.

We investigate two effects that may induce savings banks to hold more liquid assets for each unit of sight deposits than regulatorily required so that they would not transform sight deposits into illiquid assets as intensively as the regulator permits. The first effect, which we call the underestimation effect, occurs if the regulator underestimates the likelihood of deposit withdrawals and when liquidity shortages are expensive. The second effect, which we call the lending effect, occurs when savings banks have limits in non-bank lending which they do not offset through investments in other illiquid assets, such as medium-term interbank lending and/or investments in fixed assets. Disentangling these two effects is important because both effects can induce savings banks to use sight deposits less intensively to finance illiquid assets than allowed and because they require different responses by the regulator. If the first effect is at work, the regulator may want to re-specify regulatory weights to capture potential deposit withdrawals adequately, while if the latter effect is at work, there is currently no necessity to change the weighting of sight deposits used by the liquidity regulation.

Looking at bank reports of German savings banks for 2000-2006, we find evidence that a higher amount of sight deposits is associated with much more liquid assets holdings than the regulator requires, while a higher amount of other short-term payment obligations is associated with an amount of liquid assets holdings closer to the one required by the regulator. To investigate whether the regulation underestimates deposit withdrawals, we look at historical changes in sight deposits. Our findings suggest the liquidity regulation captures actual deposit withdrawals quite adequately in our sample. Thus, the withdrawal rate of sight deposits specified in the liquidity regulation can be considered as conservative and does, therefore, not explain why savings banks hold much more liquid assets than the regulator requires. To investigate whether

the lending effect force savings banks to hold more sight deposits in liquid assets than required, we test whether savings banks with high shares of loans to non-banks use sight deposits more intensively to finance illiquid assets than savings banks with low shares of loans to non-banks. Using an interaction term within a dynamic panel data approach and controlling for non-bank lending and the deposit-liability ratio, we find liquid assets depend negatively on the interaction between non-bank lending and sight deposits. This finding suggests that it is not profitable for savings banks with low lending to non-banks to transform sight deposits into other illiquid assets such as medium-term interbank lending or securities stated as fixed financial assets. It may imply that it is more profitable for savings banks with low non-bank lending to hold liquid assets than to grant medium-term interbank loans or to hold securities to maturity to use the advantages of financial reporting (i.e., gemilderte Niederstwertvorschrift).

Our paper expands the recent literature on banks' liquidity, which has, broadly speaking, focused on reserve requirements (Bartolini et al. 2001, Jallath-Coria et al. 2002), securities holdings and cash balances (Aspachs et al. 2005, Freedman and Click 2006), and the creation of liquidity (Berger and Bouwman 2006), i.e., transforming short-term liabilities into illiquid assets, but not on regulatory liquidity requirements.[1] In our paper, we consider insights gained in this literature, such as the role of the interbank market: if banks' liquidity shocks are imperfectly correlated, banks can protect themselves against liquidity shortages by being active in the interbank market (Rochet and Tirole 1996). Therefore, we control for savings banks' activity in the interbank market. Other insights, such as the role of central banks as a lender of last resort for banks' liquidity (e.g., Pagratis 2005, Carletti et al. 2006, Repullo 2003, Aspachs et al. 2006), are not particularly relevant for our paper, since we focus on savings banks that are organized in a liquidity network.

The remainder of the paper is organized as follows. In Section 2, we give an overview of the current and past prudential regulatory framework for liquidity in Germany. In Section 3, we present predictions on the relationship between regulatory liquid assets and sight deposits. In Section 4, we describe the dataset and Section 5 presents our estimation methodology and findings. Section 6 summarizes our main findings and suggests topics for future research.

[1] Recent literature dealing with the liquidity regulation is primarily descriptive. For example, Moch and Schöning (2008) provide some evidence that savings banks use Principle II (in addition to other methods) to monitor their liquidity positions.

2 *Prudential Liquidity Regulation in Germany*

Revisions in liquidity regulation

In recent years, the German liquidity regulation for banks has undergone several revisions. Banks' liquidity requirements are specified in Section 11 of the Banking Act, which state that banks "must invest their funds in such a way as to ensure that adequate liquidity for payment purposes is guaranteed at all times" (FBSO 1998a, p. 7). Since 2007, Section 11 of the Banking Act has been made concrete by the Regulation on the Liquidity of Institutions (*Liquiditätsverordnung*). Between 2000 and 2006, which is our sample period, Section 11 of the Banking Act was made concrete by Principle II (Grundsatz II), while before 2000 it was made concrete by the original Principle II and Principle III (Grundsatz II and III).

The Regulation on the Liquidity of Institutions encompasses Principle II by requiring banks to calculate and to report liquidity ratios (Standardized Approach, stated in Sections 2-7), but expands on Principle II by allowing banks to use their own liquidity models (Section 10) that have to be approved by the regulator. Thus, for those banks not opting to use their own liquidity model, the requirements of the liquidity regulation – apart from some smaller changes – did not change in 2007.

The Regulation on the Liquidity of Institutions, as did Principle II, does not only require the calculation of regulatory liquidity ratios (RLRs) but also three observation ratios on the basis of institutions, not groups of credit institutions (FBSO 1998a). All of these ratios are to be reported at the end of each month. The RLR is the quotient of assets available within the next month and payment obligations callable within the next month (FBSO 1998a). The liquidity of a bank is deemed as adequate if the RLR is at least one. The observation ratios are calculated for three different time bands: from one to three months, from three to six months, and from six to twelve months. The purpose of these ratios is to provide information on possible refunding problems; these ratios do not need to be greater than one. Excess liquidity in one time band can compensate for a liquidity shortage in the next higher time band.

Principle II was intended to adapt the German regulatory structure to international standards by taking into account not only the style of EU liquidity schemes but also recent developments in credit institutions' business environment (FBSO 1998a). Therefore, Principle II differed from the original Principle II and Principle III in several respects. First, it was built on the proposition that a solvent and profitable bank should face no obstacles in ensuring medium- and long-term refunding (Deutsche Bundesbank 1999, p. 29). In the short run, however, solvent and profitable institutions may face the risk of liquidity shortages (FBSO 1998). It focuses, therefore, on withdrawal risks of liabilities and refunding risks in the short run (Schöning 2004a, Spörk and

Auge-Dickhut 1999). The original Principle II and Principle III, in contrast, focused on the middle and long-term liquidity needs of banks and put emphasis on refunding risks resulting from banks' maturity transformation (Hartmann-Wendels and Wendels 1999, Spörk and Auge-Dickhut 1999). In so doing, they expanded on (i) the golden banking rule by specifying that long-term (medium-term) assets were to be financed by long-term (medium-term) liabilities, (ii) the deposit base theory by assuming that callable deposits were not withdrawn at once, but were available to the banks for a longer period, and (iii) the shiftability theory by specifying that particular asset types did not need to be funded by liabilities with the same maturity (Schöning 2004a). A third source of liquidity risk, the time risk, was not captured by Principle II and the original Principle II and III (Grelck and Rode 1999). Second, Principle II was based on residual maturities, while the original Principle II and III were founded on original maturities.[2] Third, Principle II allowed market values to be taken into consideration for particular liquid assets, while the original Principles II and III were based on book values only. The information content of the regulatory liquidity and observation ratios can be improved when market values instead of book values are used (Spörk and Auge-Dickhut 1999). Thus, Principle II combined a maturity-mismatch approach (since residual maturities of liquid assets and payment obligations are used when calculating regulatory liquidity and observation ratios) with a stock-market approach (since securities traded on a regular stock market are classified as highly liquid assets) (Schöning 2004b).

Main positions in savings banks' RLRs

While the liquidity regulation requires many liquid assets and short-term payment obligations to enter the RLR (see Table 2 for a detailed overview), there are only few main positions in savings banks' liquid assets and payment obligations. The liquidity regulation considers several on-balance sheet as well as off-balance sheet liquid assets and payment obligations. For example, regulatory liquid assets comprise debt and equity securities not stated as financial fixed assets that are admitted for trading on a regular market, repayment from loans maturing within the next month, as well as irrevocable lending commitments received by credit institutions. Regulatory short-term payment obligations comprise a regulatorily specified percentage of liabilities that are either due on demand or mature within the next month as well as payment obligations in the form of placement and underwriting commitments or undrawn irrevocable credit facilities. To gain insights into their relative importance, Table 3 presents the most relevant regulatory liquid assets and short-term payment obligations as a percentage of the

[2] An amendment to Section 39 (4) of the Regulation on the Accounting of Banks and Financial Services Institutions (*Verordnung über die Rechnungslegung der Kreditinstitute*, RechKredV) requires that banks' post-1998 balance sheets have to be based on residual maturities, whereas previously they were based on original maturities. Section 7 of Principle II defines residual maturities as the time between the reporting day and the respective due date.

numerator and denominator of the RLR. All the assets and obligations listed in Table 2 but not in Table 3 play a minor role for savings banks.

The most relevant regulatory liquid assets are debt securities (33%), followed by securities listed in a regular market (16%), shares in money market and securities funds (16%), and loans maturing within the next month to customers (16%) and credit institutions (11%). Off-balance sheet positions, such as irrevocable lending commitments received by credit institutions, are not very important for regulatory liquid assets. The regulatory liquid assets selected account for almost 95% of the numerator of the RLR.

The most relevant short-term payment obligations entering into the denominator of the RLR are customer liabilities maturing within the next month (37%), savings deposits (28%), customer liabilities that are due on demand (15%), and liabilities to credit institutions that will mature within the next month (5%). Thus, the denominator of the RLR is dominated by customer liabilities – which is, as we are looking at savings banks, not much of a surprise. Off-balance sheet positions are not very important for short-term payment obligations. The regulatory short-term payment obligations selected account for about 92% of the denominator of the RLR.

3 Predictions

Predictions are gained from the literature focusing on reserve requirements since these requirements are, from an economic point of view, comparable to regulatory liquidity requirements (for models dealing with reserve requirements, see Freixas and Rochet (1997), chapter 8, Baltensperger and Milde (1987), chapter 2). As in the case of reserve requirements, we can think of prudential regulatory liquidity requirements as an additional constraint in a bank's profit maximization problem (in addition to the internal liquidity constraint). The liquidity regulation requires banks to fulfill the following constraint:

$$RLR = LA^T / (LB^S + LB^O) \geq 1 \quad \Leftrightarrow \quad LA^T \geq LB^S + LB^O , \tag{1}$$

where LA^T denotes regulatory liquid assets, LB^S denotes regulatory sight deposits (i.e., 10% of the sight deposits at the bank's disposal), and LB^O denotes the amount of other regulatory short-term payment obligations (including, e.g., 10% of its savings deposits and 100% of its customer liabilities maturing within the next month).

When the liquidity regulation introduces a binding constraint, i.e., *RLR=1*, we expect banks will hold one unit of regulatory liquid assets for each unit of regulatory short-term payment obligations. This unit of regulatory liquid assets can be in the form of either securities holdings or repayments from loans maturing within the next month. If the repayments from loans maturing within the next month are sufficiently high to meet the regulatory liquidity constraint,

the regulator permits banks to use as much as 100% of the sight deposits at their disposal to grant illiquid loans to non-banks or credit institutions and/or to invest in securities stated as financial fixed assets (both of which are not factored in the numerator of the RLR).

The regulator intervenes when the bank fails to meet the requirements specified by the liquidity regulation.[3] This is not in the interest of the bank managers, since they either loose control of their banking operations or are restricted in conducting them. The bank can reduce the probability of a regulatory intervention by having regulatory liquid assets for each unit of short-term payment obligations in excess of regulatory requirements. Thus, the danger of a regulatory intervention may induce the bank to build up and to keep a liquidity buffer. Then equation (1) changes to:

$$LA^T = \alpha_1 (LB^S + LB^O) \qquad \text{with } \alpha_1 > 1. \tag{2}$$

We bring forward two effects, both of which can induce savings banks to hold an amount of liquid assets per unit of sight deposits that exceeds the one per unit of other short-term payment obligations. The first effect, which we call the underestimation effect, exists when the liquidity regulation underestimates actual deposit withdrawals, while the second effect, which we call the lending effect, exists when savings banks with low non-bank lending hold more liquid assets than savings banks with high lending to non-banks. Disentangling these two effects is essential, because the regulator may want to change the weighting in the liquidity regulation only if it currently underestimates actual withdrawal rates.

As to the underestimation effect, the bank will hold excess regulatory liquid assets for each unit of sight deposits when the liquidity regulation underestimates deposit withdrawals and when liquidity shortages are expensive. The liquidity regulation underestimates deposit withdrawals, when the actual deposit withdrawal rate, $\Delta_m D^W$, exceeds the monthly sight deposit withdrawal rate of 10% specified in the liquidity regulation. Such underestimated deposit withdrawals induce savings banks to hold more sight deposits in securities and cash balances than regulatorily required, if the price per unit of the liquidity shortage exceeds the price for sight deposits.

Banks that mainly store liquidity (Saunders and Cornett 2006) are not only interested in monthly deposit withdrawal rates, they also care about the correlation of deposit withdrawals over time. To sketch the implications on liquid assets of a bank being hit by deposit withdrawals in several subsequent months, we assume the bank, which has only sight deposits and equity at its disposal, initially has an RLR of 2 and is hit, ceteris paribus, in all subsequent months by deposit withdrawals amounting to either 2% or 10%. When the bank is only hit by a 2% deposit

[3] The regulator does not necessarily intervene if the bank fails to meet the regulatory requirements in a single month. If, however, liquidity problems are somewhat persistent, the regulator will intervene.

withdrawal in all subsequent months, the bank meets the regulatory liquidity requirement in all up to the sixth month. However, when the bank is hit by a 10% deposit withdrawal in each period, it meets the regulatory liquidity requirement in the first but not in the second month. Thus, when the bank mainly stores liquidity and when it expects deposit withdrawals in subsequent months, $\Delta_s D^W$, that exceed the regulatory withdrawal rate, it holds, on average, more liquid assets than a bank that expects deposit withdrawals not to be correlated over time. In this case, the regulatory constraint will force banks to hold excess liquidity even if the observed average RLR does not indicate that it is binding. This brings us to our first prediction.

Prediction 1: How intensively sight deposits are used to finance illiquid assets depends upon banks' deposit withdrawal rates. Banks with higher deposit withdrawal rates in a single month or within subsequent months than assumed by the regulator, i.e., $\Delta_m D^W > 10\%$ or $\Delta_s D^W > 10\%$ hold more regulatory liquid assets for each unit of sight deposits than their respective counterparts.

As to the lending effect, the degree to which the bank transforms sight deposits into illiquid assets may depend upon its lending to non-banks, *L*. At first sight, one might argue that a higher lending to non-banks will be negatively correlated with liquid assets since a bank with low non-bank lending will naturally opt for more liquid asset holdings, which leads to regulatory liquid assets in excess to the regulatory requirements. But a bank with low non-bank lending can realize the same degree of transforming sight deposits into illiquid assets than a bank with high amounts of non-bank lending when it invests more into securities not stated as fixed financial assets and/or when it grants loans to other credit institutions with an initial maturity of more than 1 month. Both, interbank lending with an initial maturity of more than 1 month and securities stated as financial fixed assets are not regulatorily specified as liquid assets.

To identify whether such an effect is at work, we measure the relationship between liquid assets and sight deposits for those banks with high lending to non-banks and those banks with low non-bank lending separately. For all banks, we expect the amount of liquid assets held for each unit of sight deposits, $\alpha^1_{1,S}$, will be strictly larger than one, while for those banks with high non-bank lending, we expect that they will use sight deposits more intensively to grant illiquid loans, so that they have fewer liquid assets for each unit of sight deposits, i.e., $\alpha^2_{1,S} < 0$. Our second prediction summarizes the effects of lending to non-banks on regulatory liquid assets.

Prediction 2: How intensively sight deposits are used to finance illiquid assets depends upon banks' lending to non-banks. Banks with high non-bank lending, $D^L=1$, hold fewer regulatory liquid assets for each unit of sight deposits than banks with low non-bank lending, $D^L=0$:

$$LA^T = \alpha^1_{1,S} LB^S + \alpha^1_{1,O} LB^O + \alpha^2_{1,S} \cdot D^L \cdot LB^S + \alpha^2_{1,O} \cdot D^L \cdot LB^O + \alpha_2 \cdot L$$
$$\text{with } 1 < \alpha^1_{1,O} < \alpha^1_{1,S} \text{ and } \alpha^2_{1,S} < \alpha^1_{1,O} \leq 0 \text{ and } \alpha_2 < 0. \tag{3}$$

4 The Data

Regulatory liquid assets and short-term payment obligations

We analyze the regulatory reporting data on savings banks' liquidity for the period 2000-2006. We focus on savings banks for two reasons. First, to perform a dynamic panel data analysis, we need a sample of banks that are relatively homogenous and whose number is sufficiently large. Savings banks are relatively homogenous with respect to their business model for granting loans and raising funds and they are a large group of banks. Second, the Regulation on the Liquidity of Institutions encompasses Principle II by requiring banks to report RLRs but it extends Principle II by allowing banks to use own liquidity models to calculate and report on their liquidity. While we expect large banks with complex business models will start using their own models, we expect smaller banks – such as savings banks – to continue to report RLRs. Therefore, we expect that a study built on data originated by Principle II, such as ours, will provide information on transforming sight deposits into illiquid assets that will be observed under the Regulation on the Liquidity of Institutions.

Our measures of regulatory liquid assets and short-term payment obligations are based on December reports under Principle II. We use the following three measures for regulatory liquid assets: (i) total regulatory liquid assets, LA^T, (ii) debt and equity securities holdings, LA^S, and (iii) cash balances, LA^C. These three measures allow us to identify whether savings banks have excess total regulatory liquid assets for their regulatory short-term payment obligations, which would imply they hold liquidity buffers, and whether they have securities holdings and cash balances for each unit of sight deposits in excess to regulatory requirements. Since all these measures are size-sensitive, we scale them as a percentage of total assets. Table 4 shows that, on average, regulatory liquid assets account for approximately 36% of total assets, debt and equity securities for 24% and cash balances for about 2.3%.

For regulatory short-term payment obligations, we use the following measures: (i) total regulatory short-term payment obligations, LB^T, (ii) regulatory sight deposits of non-banks, LB^S, (iii) and other regulatory short-term payment obligations, LB^O. All measures for regulatory short-term payment obligations used in our empirical analysis are the regulatory amounts relative to total liabilities (in percent), i.e., regulatory sight deposits, LB^S, are calculated as (0.1×sight deposits)/(total assets). Total regulatory short-term payment obligations account for more than 13% of bank assets; the minimum is as low as 5% and the maximum is as high as

29%. Regulatory sight deposits account for 1.9% of savings banks' total assets (i.e., 19% of savings banks' total assets), on average; the minimum is as low as 0.7%, while the maximum is below 4%. Other regulatory short-term payment obligations account for more than 11%, on average, ranging from 2% to more than 27%.

Controls

Our control variables, which we introduce in the following, capture bank-specific characteristics and the macroeconomic environment.

Concerning bank-specific characteristics, we control for the ratio of loans to non-banks relative to total assets, L, and the annual growth in loans to non-banks, ΔL. On average, as Table 4 shows, savings banks use almost 60% of their assets to grant loans to non-banks. However, this number varies from as low as 12% to almost 90%. The stock of loans to non-banks grows on average by 1% per year.

We control for bank size, *SIZE,* measured by the logarithm of a bank's total assets, because we expect it to be correlated with using sophisticated liquidity management techniques which impact on liquid assets. In particular, large banks are more likely to use sophisticated techniques of managing liquidity risk than small banks because the costs of implementing such a technique might be independent of bank size, while the benefits certainly do. Banks that use sophisticated liquidity techniques likely hold smaller volumes of liquid assets. In addition, bank size may be correlated with using purchasing liquidity techniques, since using such a technique may have fixed-cost character.

Finding a more precise measure than size for capturing whether savings banks employ purchased liquidity techniques is difficult, since savings banks are part of liquidity networks that they use to manage their liquidity when monetary policy conditions change (Ehrmann and Worms 2004). Thus, *per se*, all savings banks have access to purchased liquidity. However, we expect the positions of savings banks within the liquidity network in terms of price and quantity conditions to differ and therefore we count the number of connections the bank has as a borrower in the interbank market. The number of these interbank connections is greater than one because the formerly strong single relationship between savings banks and their head institutions has become much weaker in the past few years so that head institutions in northern Germany also offering liquidity to savings banks in southern Germany. We expect the number of interbank connections relative to total assets, IB, to be negatively related to liquid assets. Such a negative relationship arises when interbank connections are negatively related to the conditions of purchasing liquidity. However, a negative relationship can also arise when some banks faced a strong loan demand in the past, which forced them to shift liquid assets into

illiquid loans first (as much as the regulator permits) and afterwards to raise additional funding. In either case, we expect a bank with many interbank connections will hold fewer liquid assets.

Moreover, we control for the interest margin, *IM*, which measures the banks' opportunity costs of holding liquid assets in terms of forgone higher returns from loans (Aspachs et al. 2005). Therefore, we expect the interest margin will affect regulatory liquid assets negatively.

Concerning the macroeconomic environment, we control for the change in the short-term interest rate, Δi, and the real GDP growth rate, ΔGDP. Because an increase in short-term interest rates increases the opportunity costs of holding cash, we expect regulatory liquid assets will change from being cash balances towards being securities holdings. An increase in GDP growth likely coincides with an increase in the loan demand. Therefore, we expect savings banks will reduce their securities holdings. The effect on total regulatory liquid assets is undetermined, since securities holdings may decrease, while repayments from loans and advances maturing within the next month may increase if the economy expands (since companies' failure rates go down). Additionally, we include year dummies to further control for time-fixed effects.

5 Underestimated Deposit Withdrawals or Limits in Non-Bank Lending?

5.1 Underestimated Deposit Withdrawals

According to our first prediction, savings banks may hold more regulatory liquid assets than regulatory required because the liquidity regulation underestimates the likelihood of sight deposit withdrawals. To identify whether this underestimation effect is at work requires identifying those banks with higher withdrawal rates than regulatorily specified. Figure 1 plots the changes in sight deposits calculated from monthly, quarterly, semi-annual, and annual stocks of sight deposits since savings banks may not only care about deposit withdrawals within one month but within subsequent months. The left upper plot in Figure 1 suggests a relatively low likelihood of experiencing a monthly change in sight deposits above the regulatory value of 10%. In addition, the other three plots for quarterly, semi-annual, and annual changes in sight deposits do not indicate negative changes that would add up to more than 10% of initial sight deposits in subsequent months. These changes differ from the one which the regulator specifies, since the changes presented in Figure 1 are not controlled for growing sight deposit bases. However, even if we control for growing sight deposits bases, the distributions of sight deposit withdrawals do not change substantially.

As Figure 1 suggests, the historical changes in sight deposits seldom exceed the weight for deposit withdrawals specified by the regulator during our sample period. Thus, the regulatory

value for expected deposit withdrawals of 10% can be regarded as a conservative value. The deposit withdrawal rates depicted in Figure 1 imply that we cannot classify a group of savings banks that experience higher than regulatorily specified deposit withdrawals. Therefore, we tentatively conclude that underestimating actual withdrawal rates cannot explain why savings banks hold more regulatory liquid assets for their payment obligations than required.

However, we have two cautionary notes on this strict interpretation of our findings. First, savings banks may be risk-averse and they may not decide on the basis of historical withdrawal rates but rather may take into account that all sight deposits can be withdrawn at once. Second, the stock of sight deposits reported at the end of each month (which we used in Figure 1) can be substantially higher than if it was averaged over each month. If wages and salaries are mainly paid at the end of the month, savings banks will store part of the sight deposits in liquid assets that they can easy transform into cash to be prepared for deposit withdrawals. Of course, a deposit withdrawal from a customer's perspective does not have to coincide with a deposit withdrawal from the bank's perspective since money often changes from one account to another and since withdrawn sight deposits are compensated for by other sight or savings deposit inflows. Nevertheless, we do not know how intensively sight deposits fluctuate between the two points in time at which banks report their liquidity to the regulator.

5.2 Limits in Non-Bank Lending

According to our second prediction, savings banks may hold more regulatory liquid assets than regulatory required because it is unprofitable for them to offset limits in their lending to non-banks by investing in other illiquid assets, such as medium-term interbank lending. To test whether such an effect is at work, we interact a dummy variable, D^L, which is equal to one if the savings bank has a high ratio of loans to non-banks relative to total assets and zero otherwise, with the variables capturing short-term payment obligations. The interaction terms are potentially endogenous and we, therefore, instrument them by using past values. To yield appropriate instruments for these potentially endogenous interaction variables, we employ a time-invariant dummy variable.

The econometric models

The baseline econometric models that we use to test our second prediction takes into account dynamic changes in liquidity by including a lag of the dependent variable in the list of the RHS variables. The baseline models have the following form:

$$\begin{aligned} y_{i,t} = {} & \alpha_0 y_{i,t-1} + \sum_{j=S,O} \alpha^1_{1,j} LB^j_{i,t} + \sum_{j=S,O} \alpha^2_{1,j} D^L_i \cdot LB^j_{i,t} + \alpha_2 L_{i,t-1} + \alpha_3 \Delta L_{i,t} + \\ & \alpha_4 \log(SIZE_{i,t-1}) + \alpha_5 IB_{i,t-1} + \alpha_6 IM_{i,t} + \alpha_7 \Delta i_t + \alpha_8 \Delta GDP_t + Time\ Dummies + \varepsilon_{i,t}\ , \\ & with \quad y \in \{LA^T, LA^S, LA^C\} \end{aligned} \tag{4}$$

where $y_{i,t}$ denotes the dependent variable of interest for bank i at time t. We assume $\varepsilon_{i,t}=\gamma_i+\eta_{i,t}$, where γ_i is a bank-specific fixed effect and $\eta_{i,t}$ is a disturbance term.

Our baseline models include only those bank-specific characteristics that we discussed in Section 4, some of which are correlated as Table 5 shows. For example, interbank connections are correlated with bank size. In our baseline models, we consider only those variables that are not sensitive to alternative specifications. Thus, the effects of interbank connections and bank size on liquid assets do not depend on whether or not these variables are included jointly in the models. In extensions of these baseline models, presented below, we introduce further bank-specific characteristics, such as bank capital, and discuss their effects on regulatory liquid assets.

To estimate the baseline and extension models, we take into account that some RHS variables are endogenous; some variables have even been used as dependent variables in other empirical studies. For example, the growth in loan stocks is analyzed by Kashyap and Stein (2000), Ashcraft (2006), Kishan and Opiela (2000), and Merkl and Stolz (2006), among many others. Bank capital and its interdependency with risk-weighted assets is analyzed by Shrieves and Dahl (1992), Jacques and Nigro (1997), Aggarwal and Jacques (2001), Rime (2001), and Heid et al. (2004). To minimize endogeneity problems, we use lagged variables whenever the variable under focus is related to one point in time only, i.e., we use the lagged ratio of loans to non-banks relative to total assets, interbank connections, and capital, while we instrument those variables that are calculated from two points in time, i.e., loan growth.

We estimate all following models by using the dynamic panel data estimator (which is a generalized method of moments estimator) proposed by Blundell and Bond (1998) and a finite sample correction proposed by Windmeijer (2005). Estimation results will be consistent if we use appropriate instruments for the lag of the dependent variable and RHS variables, and if there is no higher-order autocorrelation. We vary instruments in a systematic way and use a test for overidentifying restrictions to select the models presented in Table 6 (Arellano and Bond 1991, Blundell and Bond 1998). Since we estimate a dynamic model, each variable has both first-round and second-round effects. For example, an increase in the ratio of loans to non-banks relative to total assets in t impacts liquid assets in t, which in turn impacts liquid assets in $t+1$. Therefore, we also report the long-run coefficients.

Results of the baseline models

We present estimation results of the baseline models for the three measures of liquid assets in Table 6.

The interaction terms between the dummy variable equal to one for those savings banks with high lending to non-banks and the two types of short-term payment obligations shed light on the

relevance of our second prediction. We estimate each interaction term in a separate equation because the two terms are highly correlated. The interaction term of sight deposits impacts significantly negatively on total regulatory liquid assets (column 1), suggesting that savings banks with high non-bank lending use a greater amount of sight deposits to finance illiquid assets than banks with low non-bank lending. In the long-run, in which second-round effects are taken into account, regulatory liquid assets held for each unit of sight deposits are 1.3 units lower for savings banks with high non-bank lending than for banks with low non-bank lending. Since total regulatory liquid assets comprise repayments from loans and advances maturing within the next month, the results for total regulatory liquid assets do not provide information on whether savings banks actually store more sight deposits in liquid assets than regulatory required. Therefore, we report results for securities holdings and cash balances. For each unit of regulatory sight deposits, savings banks with high non-bank lending store 1.8 units less in securities than savings banks with low non-bank lending (column 2), while the interaction term for cash balances is insignificant (column 3). The interaction terms of other regulatory short-term payment obligations are insignificant throughout (columns 4-6). These findings support our second prediction: savings banks do not transform sight deposits into illiquid assets to the degree permitted by the regulator because they face limits in their lending to non-banks which they do not offset by investing in other illiquid assets.

Our findings also indicate that savings banks with low and high non-bank lending hold significantly more regulatory liquid assets per unit of sight deposits than required by the regulator. For savings banks with low non-bank lending, one unit of regulatory sight deposits is associated with 5.69 units of regulatory liquid assets in the long-run. For savings banks with high non-bank lending, one unit of regulatory sight deposits is associated with 4.38 (=5.69-1.31) units of regulatory liquid assets in the long-run. Thus, even savings banks with high non-bank lending do not transform sight deposits into illiquid assets to the extent permitted by the liquidity regulation. This effect might be caused by a lower availability of sight deposits within one month.

Noteworthy is also the long-run coefficient of other regulatory payment obligations, since it indicates each unit of these obligations is associated with more regulatory liquid assets than required: For each unit of these obligations, savings banks have 1.7 times the amount of total regulatory liquid assets required by the liquidity regulation. This finding indicates that savings banks hold a liquidity buffer. However, the liquidity buffer we estimated seems to be rather large. One reason for such a large liquidity buffer might be that savings banks manage their liquidity in such a way that they can meet regulatory liquidity requirements even if they are seeking to expand their loans to non-banks. Savings banks aiming at expanding their loans to non-banks may reserve the repayments from loans and advances (which are factored into the

numerator of the RLR) for the funding of new illiquid loans (which are not factored into the denominator of the RLR). In line with this reasoning is the less pronounced effect of other short-term payment obligations on debt and equity securities and cash balances: one unit of other regulatory obligations is associated with 0.66 units of securities and 0.05 units of cash balances. Thus, with respect to securities and cash balances, savings banks do not, per se, hold liquidity buffers. This implies savings banks need some of the repayments from loans and advances maturing within the next month to meet the requirements in the liquidity regulation.

Several of our control variables related to bank-specific characteristics and the macroeconomic environment help in explaining regulatory liquid assets. Total regulatory liquid assets, securities, and cash balances are lower when savings banks have higher shares of loans to non-banks relative to total assets. Additionally, savings banks reduce their securities holdings when they increase loans to non-banks, while they do not reduce their cash balances significantly irrespective of whether or not cash balances contain lending commitments received by other institutions. This might be because cash balances are kept at a minimum and that this minimum is necessary to meet reserve requirements.

Bank size, i.e., the logarithm of total assets, and savings banks' interbank connections relative to total assets impact significantly negatively on regulatory liquid assets. Thus, larger savings banks and savings banks with more connections in the interbank market in the last period have a smaller volume of regulatory liquid assets in the current period. As argued in the last section, savings banks with multiple connections may hold a smaller amount of liquid assets either because they do not have to prepare for liquidity shortages as much as their counterparts do or because they used their liquid assets in the past to grant illiquid loans before they started to raise additional funds in the interbank market which increased their number of connections.

As to the macroeconomic environment, coefficients have the expected signs: an increase in GDP growth or in the short-term interest rate reduces total regulatory liquid assets. However, the types of regulatory liquid assets are differently affected by changes in the macroeconomic environment. An increase in the short-term interest rate, which increases the opportunity costs of holding cash, results in higher securities holdings, while it leads to lower cash balances. An increase in GDP growth, which may be associated with increasing loan demands, results in smaller securities holdings, whereas it results in larger cash balances. Thus, when the economy expands, savings banks change their composition of liquid assets towards those assets that we classified as being more liquid. This might be because savings banks need liquidity to be prepared to provide additional loans to non-banks.

To further test the robustness of our findings, we use a sample in which only savings banks not involved in mergers and acquisitions are included. This sample is a balanced panel data set, i.e.,

the number of observations is equal for each bank included. Using this sample allows us to figure out whether banks involved in mergers and acquisitions drive the estimation results in Table 6. Employing this sample confirms our estimation results: the coefficients of sight deposits and other short-term payment obligations do not change at all.

Since actual withdrawal rates do not induce savings banks to hold more regulatory liquid assets than required, the question arises why savings banks do not reduce the amount of sight deposits when they cannot use it to finance illiquid assets as intensively as permitted by the regulator. We have three reasons to explain this behavior. First, the costs per unit of sight deposits may be less than the returns per unit of liquid assets, giving savings banks an incentive to collect as many sight deposits as possible and hold them in liquid assets. This strategy is, however, not riskless, as it is subject to market risks. Second, reducing the amount of sight deposits might not only lower the number of depositors but also the number of other customers (cross-selling). Finally, reducing the amount of sight deposits implies banks' size may shrink which may not mesh with the interests of managers, who may equate bigger with better (empire building).

Extensions

We use extensions of the baseline models to gain insights on whether bank capital and risks in the loan portfolio, impact on regulatory liquid assets significantly. None of the model extensions alters the insights we gained with respect to the short-term payment obligations and, more specifically, with respect to sight deposits. The results of these extensions are not reported but are available upon request.

As for bank capital, *CAPITAL*, the recent literature hypothesizes that it absorbs risks. When banks mainly employ purchased liquidity techniques, banks' capital is expected to affect securities holdings negatively. A well-capitalized bank may raise funds at a lower cost, as capital absorbs risks and expands a bank's risk-bearing capacity (the *risk-absorption hypothesis*, see Bhattacharya and Thakor 1993, Repullo 2004). As a consequence, a well-capitalized bank is expected to have only the amount of regulatory liquid assets required by the regulator and to use the remaining funds for lending. Since savings banks purchase only a relatively small amount of their liquidity (see Table 3),[4] it is, however, unlikely that bank capital has a tremendous risk-absorbing effect for them.

Alternatively, Principle I, which implemented the Basel I Accord in Germany and was in force during our sample period, may cause a negative relationship between bank capital and liquid assets. A bank very close to the regulatory threshold of the prudential capital rules may not

[4] Liabilities to credit institutions account for only about 6% of short-term liabilities maturing within the next month. In the case of a liquidity shortage, savings banks might, of course, purchase liquidity in the medium term, which would not show up in the data we use.

increase loans, since it would then fail to meet regulatory capital requirements (except if it can increase regulatory capital). Thus, the bank would hold each additional unit of debt liabilities in those liquid assets that enter the regulatory liquid assets specified under the liquidity regulation but not the risk-weighted assets specified under Principle I. By contrast, a well-capitalized bank can decide whether or not to increase loans or securities. In our model extensions, we do not employ the Basel I capital ratio, but rather loans, which determine the denominator of the capital ratio, and bank capital, which is the numerator of the capital ratio.

We run several regressions to test the impact of bank capital on liquid assets. However, the results are inconclusive. When bank capital is additionally included in our baseline models, it turns out to be significantly positively related to liquid assets, contrasting with the view of risk absorbing capacity. When the loan-asset ratio is removed from the baseline models, bank capital has no significant impact on total liquid assets and securities, while it impacts on cash balances significantly negatively.

As for risks in banks' loan portfolio, we use new loan loss provisions and loan write-offs divided by loans to non-banks, *LL,* and a Herfindahl-Hirschman index based on exposures to 23 sectors, *HHI*. New loan loss provisions and loan write-offs are used to approximate credit risk (e.g., Merkl and Stolz 2006) that determines the certainty of repayments from loans maturing within the next month. The Herfindahl-Hirschman index is used to approximate concentration risk that may impact on regulatory liquid assets since the degree of diversification of a loan portfolio determines banks' resilience against sectoral shocks. Banks with lower concentration risk due to a well-diversified loan portfolio may hold fewer liquid assets since they are less exposed to sectoral shocks than banks with a specialized loan portfolio. However, when we add these risk measures to our baseline models, we do not gain further insights.

6 Conclusions

In this paper, we analyzed the relationship between regulatory liquid assets and sight deposits, a relationship that gives insights into whether savings banks transform sight deposits into illiquid assets as intensively as permitted by the regulator. For each unit of sight deposits, banks have to show 0.1 units of regulatory liquid assets that contain, e.g., securities holdings, the cash balances and repayments from loans maturing within the next month. Thus, if banks receive sufficient repayments from loans maturing within the next month, they can use all sight deposits at their disposal to grant illiquid loans to non-banks and credit institutions or to invest into securities stated as fixed financial assets. We formulated two predictions of why savings banks hold an amount of regulatory liquid assets for each unit of sight deposits that is higher than

required by the regulator: (i) the actual withdrawal rate for sight deposits is higher than the regulator assumes (underestimation effect), and/or (ii) savings banks have limits in their non-bank lending that they do not offset by medium-term interbank lending or investments in other illiquid assets (lending effect).

Our analysis showed that savings banks actually hold an amount of regulatory liquid assets for each unit of sight deposits that is much higher than required by the regulator. As to the underestimation effect, we documented that in our sample the deposit withdrawal rate assumed by the regulator can be regarded as conservative. Thus, the underestimation effect is not present in our sample. As to the lending effect, we investigated whether non-bank lending impacts on how much sight deposits banks hold in liquid assets. Our findings suggest that savings banks with high lending to non-banks relative to total assets do not only have fewer liquid assets but do also hold a smaller volume of sight deposits in liquid assets than banks with low lending to non-banks. These findings indicate that it is more profitable for savings banks to hold liquid assets than to invest in illiquid assets, such as medium-term interbank lending to other credit institutions. However, even savings banks with high shares of loans to non-banks hold more regulatory liquid assets per unit of sight deposits than regulatorily required. We discussed several alternative explanations for why even savings banks with high shares of loans to total assets hold more regulatory liquid assets per unit of sight deposits than regulatory required. One explanation was that banks report the amount of sight deposits available at the end of the month, monthly averages of sight deposits might be lower.

Our findings suggest two areas for further research. First, while the impact of prudential capital regulation on bank behavior has been well analyzed for banks located in several countries, such as the United States and Germany, little is known about the impact of prudential liquidity regulation on bank behavior. Of particular interest is whether prudential liquidity regulation puts banks under pressure to increase their liquid assets or to decrease their short-term payment obligations as they converge to the regulatory threshold of the liquidity ratio. Second, the potential interaction between prudential capital and liquidity regulation is a relatively unexplored research area. Our findings show no clear relationship between savings banks' regulatory bank capital and regulatory liquid assets. However, we might only identify how prudential liquidity and capital regulations interact when regulatory pressure caused by capital or/and liquidity regulation is modeled jointly. In our paper, we did not focus on these questions but leave them for future research.

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Appendix: Data Definitions and Sources

Dependent variables

LA^T	Regulatory liquidity assets to total assets (Source: Deutsche Bundesbank, reports on Principle II).
LA^S	Securities based on market and book values to total assets (Source: Deutsche Bundesbank, reports on Principle II).
LA^C	Cash balances to total assets (Source: Deutsche Bundesbank, reports on Principle II).

RHS variables

Regulatory short-term payment obligations

LB^T	Regulatory short-term payment obligations to total assets (Source: Deutsche Bundesbank, reports on Principle II).
LB^S	Sight deposits of non-banks to total assets (Source: Deutsche Bundesbank, reports on Principle II).
LB^O	Other short-term payment obligations to total assets (Source: Deutsche Bundesbank, reports on Principle II).

Controls

L	Loans to non-banks relative to total assets (Source: Deutsche Bundesbank).
D^L	A dummy variable equal to 1 if L of the bank under focus is larger or equal than the 70 percentile of L, and 0 otherwise (Source: Deutsche Bundesbank).
ΔL	Growth in loans to non-banks (Source: Deutsche Bundesbank).
SIZE	Total assets (Source: Deutsche Bundesbank).
IB	Number of connections a bank has as a borrower in the interbank market relative to total assets (Source: Deutsche Bundesbank, Credit Register).[5]
IM	Interest margin calculated as interests received divided by total outstanding loans less the costs of funding (Source: Deutsche Bundesbank).
CAPITAL	Regulatory capital to total assets (Source: Deutsche Bundesbank, reports on Principle I).
LL	Loan loss defined as new loan loss provisions and loan write-offs divided by loans to non-banks (Source: Deutsche Bundesbank).
HHI	Herfindahl-Hirschman index of the loan portfolio over various sectors (Source: Deutsche Bundesbank, Borrowers Statistics (*Kreditnehmerstatistik*)).[6]
Δi	Change in the short-term interest rate (EURIBOR 1-month) (Source: Thomson Financial Datastream).
ΔGDP	Real GDP growth rate (Source: Thomson Financial Datastream).

[5] The credit register contains information on exposures larger than €1.5 million (for a description of this database see Memmel and Stein 2007). Thus, this database does often not include small savings banks. Since small savings banks are likely connected to their head institution only, we set their number of interbank connection equal to one.

[6] Deutsche Bundesbank (2004) gives a detailed definition of the loans in the borrowers statistics and the group of borrowers. According to this definition, we use loans plus mortgage loans.

Treatment of mergers and acquisitions

During the sample period, the German banking sector underwent a substantial consolidation wave. Because bank-specific variables can jump substantially when banks merge or acquire another bank, it is essential to treat mergers and acquisitions (M&A) adequately. Generally, there are three ways to handle M&A:

(i) The two pre-M&A banks are consolidated even prior to the M&A. This procedure is inadequate if the two banks are expected to have behaved differently prior to the M&A transaction.

(ii) The two pre-M&A banks and the post-M&A bank are dropped from the dataset. This procedure can result in a substantial information loss but it produces a balanced dataset, i.e. the number of observations over time is identical for those banks that remain in the dataset.

(iii) The two pre-M&A banks are separated from the post-M&A bank and the resulting three banks are handled separately. This procedure minimizes the loss of information but it produces an unbalanced panel dataset.

Descriptive statistics and estimation results presented throughout the paper are based on a sample constructed by using the third procedure. In order to avoid double counting of banks in the year of the M&A transaction, we drop banks in the year of the transaction. Moreover, in order to estimate dynamic responses in liquid assets, we need at least three observations per bank.

In our robustness section, we also employ a dataset constructed by using the second procedure, which gives useful insights into whether our estimation results are sensitive to changes.

Figure 1: Changes in sight deposits

This figure shows the changes in sight deposits calculated from monthly, quarterly, semi-annual and annual sight deposit stocks between July 2000 and December 2006.

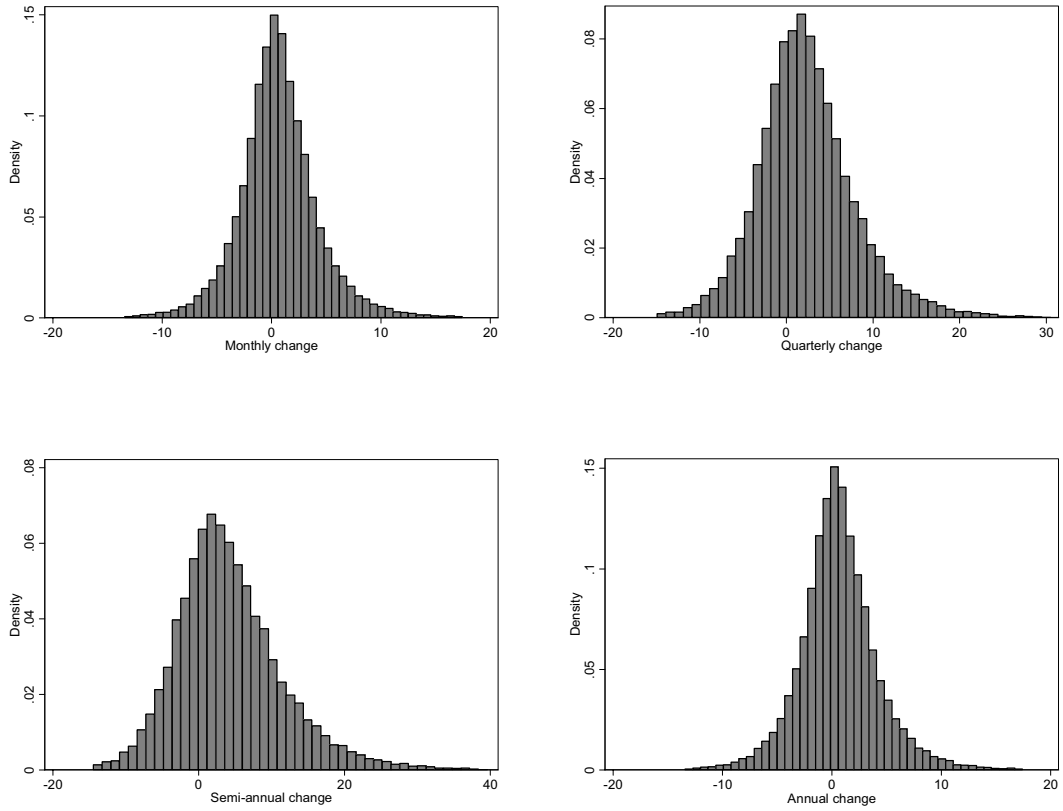

Table 1: Liquidity ratios by banking groups

This Table shows mean values and standard deviations of regulatory liquidity ratios calculated from monthly reports. The two central institutions of the cooperative banks are not included due to data confidentiality.

	2000	2001	2002	2003	2004	2005	2006
				Big banks			
Mean	1.203	1.145	1.149	1.137	1.163	1.208	1.150
Standard deviation	0.038	0.036	0.042	0.030	0.038	0.058	0.033
Number of banks	4	4	4	4	4	5	5
				State banks			
Mean	1.377	1.370	1.414	1.402	1.504	1.556	1.475
Standard deviation	0.114	0.101	0.123	0.113	0.110	0.137	0.095
Number of banks	12	12	12	11	11	11	11
				Savings banks			
Mean	2.775	2.883	2.912	2.917	2.990	3.118	2.942
Standard deviation	0.282	0.272	0.276	0.280	0.296	0.315	0.269
Number of banks	563	536	519	490	479	463	457

Table 2: Liquid assets and short-term payment obligations according to Principle II

This table provides information on liquid assets and short-term payment obligations (liabilities) which enter into the regulatory liquidity ratio. Weights are given in parentheses if they are not equal to 100%. The assessment basis of liquid assets is either the current market value, the repurchase price, the amount repayable, or the book value. Source: FBSO (1998b).

Liquid assets		Liabilities
• Cash • Balances with central banks • Documents send for collection • Irrevocable lending commitments received by the institutions • Securities not stated as financial fixed assets which are admitted for trading on a regulated market (*market prices*) • Debt securities (*market prices*) • Shares in money market and securities funds (90% of the respective *repurchase price*)		• Liabilities to credit institutions due on demand (40%) • Customer liabilities due on demand (10%) • Savings deposits (irrespective of the period of notice) (10%) • Contingent liabilities from rediscounted bills guarantees and indemnity agreements (5%) • Liabilities from assets pledged as collateral for third-party liabilities (5%) • Placement and underwriting commitments (20%) • Undrawn irrevocably granted credit facilities (20%)
Assets according to their residual maturity	≤	Liabilities according to their residual maturity
• Receivables from the ESCB, credit institutions, and customers • Bills of exchange • Claims on lending institutions to the return of the securities lent (*market prices*) • Particular debt securities • Claims of the transferor for the retransfer of securities within the framework of genuine repurchase agreements (*market prices*) • Pecuniary claims of the transferee arising from non-genuine repurchase agreements in the amount of the agreed repurchase price, provided that the current market value is lower than the agreed repurchase price (*amounts to be repaid*) • Equalization claims on the public sector		• Liabilities to the ESCB and other central banks • Liabilities to credit institutions • Liabilities of the central institutions of the savings banks owed to their head institutions and of those head institutions to their affiliated savings banks • Customer liabilities • Asset-related liabilities of the borrowing institution to return borrowed securities (*market prices*) • Asset-related liabilities of the transferee resulting from the duty to return securities within the framework of repurchase agreements (*market prices*) • Pecuniary liabilities of the transferor arising from non-genuine repurchase agreements in the amount of the agreed repurchase price, provided that the current market value is lower than the agreed repurchase price (*amounts to be repaid*) • Securitized liabilities (*amounts to be repaid*) • Subordinated liabilities (*amounts to be repaid*) • Capital represented by participation rights • Other liabilities

Table 3: Main positions in savings banks' regulatory liquidity ratio

This table provides information on the main positions of liquid assets and short-term payment obligations in savings banks' regulatory liquidity ratios. Positions that belong to the liquid assets specified in Principle II are expressed in percent of total regulatory liquid assets (i.e. the numerator of the ratio), and short-term liabilities are expressed in percent of total short-term payment obligations (i.e. the denominator of the ratio).

Liquid assets	**Included in …**	**Min.**	**Mean**	**Max.**
Cash	LA^T, LA^C	0.21	1.94	16.92
Irrevocable lending commitments received by the institutions	LA^T, LA^C	0.00	0.19	39.57
Securities not stated as financial fixed assets which are admitted for trading on a regular market (*market prices*)	LA^T, LA^S	0.00	16.08	80.23
Debt securities (*market prices*)	LA^T, LA^S	0.00	33.32	85.58
Shares in money market and securities funds	LA^T, LA^S	0.00	16.46	85.41
Loans and advances to credit institutions (maturing within the next month)	LA^T	0.00	10.54	84.46
Loans and advances to customers (maturing within the next month)	LA^T	0.00	16.14	87.62

Short-term liabilities	**Included in …**	**Min.**	**Mean**	**Max.**
Liabilities to credit institutions due on demand	LB^T, LB^O	0.00	0.68	34.91
Customer liabilities due on demand	LB^T, LB^S	0.00	15.36	58.64
Savings deposits (irrespective of the period of notice)	LB^T, LB^O	0.00	28.44	66.64
Contingent liabilities	LB^T, LB^O	0.00	0.93	23.59
Undrawn irrevocably granted credit facilities	LB^T, LB^O	0.00	3.94	45.69
Liabilities to credit institutions (maturing within the next month)	LB^T, LB^O	0.00	4.75	72.40
Customer liabilities (maturing within the next month)	LB^T, LB^O	0.00	36.86	81.73
Securitized liabilities	LB^T, LB^O	0.00	1.12	54.48

Table 4: Descriptive statistics

This table depicts descriptive statistics of the dependent and RHS variables used in our analysis. For data definitions see the Appendix.

	Variable	Mean	Std. Dev.	Min	Max
Total regulatory liquid assets	LA^T	35.75	10.33	9.48	72.45
Securities	LA^S	23.97	10.36	0.00	61.33
Cash balances	LA^C	2.29	0.78	0.65	7.68
Total short-term payment obligations	LB^T	13.35	3.80	4.81	28.94
Sight deposits	LB^S	1.90	0.57	0.67	3.70
Other short-term payment obligations	LB^O	11.45	3.97	2.17	27.44
Loans to non-banks	L_{t-1}	59.36	12.01	12.10	89.89
Growth in loans to non-banks	ΔL	0.97	4.02	-24.07	29.48
Bank total assets (in € million)	$SIZE_{t-1}$	1804.76	2232.11	127.67	31784.68
Interbank connections	IB_{t-1}	0.41	0.33	0.01	2.05
Interest margin	IM	2.10	0.39	0.46	3.57
Loan write-offs	LL_{t-1}	1.10	0.75	0.03	7.91
Herfindahl index	HHI_{t-1}	0.10	0.02	0.07	0.24
Regulatory capital	$CAPITAL_{t-1}$	6.93	1.23	3.49	12.64
Change in short-term interest rate	Δi	-1.79	30.19	-37.89	57.48
GDP growth rate	ΔGDP	1.02	1.07	0.03	3.04

Table 5: Correlations

This table gives correlation coefficients of the dependent and RHS variables used in the empirical analysis. For variable definitions see the Appendix.

	LA^T	LA^S	LA^C	LB^T	LB^S	LB^O	L_{t-1}	ΔL	LL_{t-1}	HHI	$CAPITAL_{t-1}$	IB_{t-1}	$\log(SIZE_{t-1})$	IM	Δi	ΔGDP
LA^T	1															
LA^S	0.9140*	1														
LA^C	0.2821*	0.2144*	1													
LB^T	0.1948*	0.0941*	0.0632*	1												
LB^S	0.1650*	0.1736*	0.1557*	-0.2221*	1											
LB^O	0.1629*	0.0652*	0.0382*	0.9901*	-0.3567*	1										
L_{t-1}	-0.0822*	-0.0846*	0.0648*	0.1362*	-0.1836*	0.1569*	1									
ΔL	-0.7556*	-0.7272*	-0.2764*	-0.1454*	-0.2481*	-0.1036*	0.0734*	1								
LL_{t-1}	0.2353*	0.2170*	0.1704*	-0.0431*	0.1695*	-0.0657*	-0.2724*	-0.4066*	1							
HHI	0.0002	-0.0165	0.0815*	-0.0475*	0.0305	-0.0499*	0.0006	0.0052	-0.0295	1						
$CAPITAL_{t-1}$	-0.1852*	-0.1472*	-0.2243*	-0.1110*	0.0161	-0.1086*	-0.1184*	0.3550*	-0.3035*	-0.0905*	1					
IB_{t-1}	-0.1259*	-0.1145*	-0.1110*	0.2076*	-0.0478*	0.2058*	-0.0114	0.0670*	0.0377*	0.0186	-0.0842*	1				
$\log(SIZE_{t-1})$	-0.0422*	-0.0377*	-0.1265*	0.2632*	0.1883*	0.2251*	-0.027	-0.0367*	0.0358*	-0.1922*	-0.0106	0.5140*	1			
IM	-0.0187	-0.0545*	0.1294*	-0.1325*	0.0289	-0.1311*	0.0044	0.1103*	0.1080*	0.0067	0.0582*	-0.1705*	-0.2606*	1		
Δi	-0.0750*	-0.0128	-0.0562*	-0.0879*	0.1570*	-0.1068*	-0.1313*	0.0077	-0.0533*	-0.0121	0.3230*	0.0093	0.0478*	-0.0735*	1	
ΔGDP	-0.0678*	-0.0124	0.0135	-0.0530*	0.1342*	-0.0701*	-0.032	-0.0015	-0.0658*	-0.0103	0.2879*	-0.0059	0.0405*	-0.1283*	0.7931*	1

Table 6: Regulatory liquid assets

This Table shows estimation results and long-run coefficients for savings banks' total regulatory liquid assets (LA^T), securities (LA^S) and cash balances (LA^C) based on GMM estimations with absolute Windmeijer's (2005) corrected t-statistics in parentheses. y_{t-1} denotes the lag of the dependent variable. Year dummies are included. For variable definitions see the Appendix. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

			Short-run coefficients			
	(1) LA^T	(2) LA^S	(3) LA^C	(4) LA^T	(5) LA^S	(6) LA^C
		$D^L \times LB^S$			$D^L \times LB^O$	
Interaction term	-0.499**	-0.623***	0.043	-0.042	-0.13	0.006
	(2.19)	(3.07)	(1.30)	(0.22)	(0.77)	(0.17)
LB^S	2.173***	0.886***	0.255***	2.021***	0.728**	0.260***
	(5.91)	(2.75)	(4.43)	(5.11)	(2.18)	(4.52)
LB^O	0.651***	0.225***	0.043***	0.670***	0.259***	0.040**
	(7.31)	(2.97)	(3.14)	(6.78)	(3.09)	(2.57)
L_{t-1}	-0.173***	-0.165***	-0.012***	-0.185**	-0.154**	-0.012
	(4.02)	(4.45)	(4.48)	(2.53)	(2.35)	(1.36)
ΔL	-0.315***	-0.216***	-0.008	-0.327***	-0.219***	-0.008
	(6.34)	(5.33)	(1.17)	(6.46)	(5.15)	(1.02)
$\log(SIZE_{t-1})$	-1.724***	-1.123***	-0.202***	-1.760***	-1.140***	-0.200***
	(6.65)	(4.64)	(5.08)	(6.88)	(4.49)	(4.90)
IB_{t-1}	-1.414**	-1.365**	-0.175**	-1.500**	-1.416**	-0.173**
	(2.54)	(2.26)	(2.31)	(2.58)	(2.30)	(2.20)
IM	0.214	-0.158	0.194***	0.198	-0.086	0.203***
	(0.56)	(0.46)	(3.29)	(0.46)	(0.22)	(2.78)
Δi	-0.024***	0.011*	-0.009***	-0.025***	0.011*	-0.009***
	(3.39)	(1.78)	(8.94)	(3.44)	(1.75)	(9.02)
ΔGDP	-0.492**	-1.139***	0.230***	-0.487**	-1.137***	0.231***
	(2.40)	(5.67)	(9.62)	(2.38)	(5.57)	(9.43)
y_{t-1}	0.618***	0.662***	0.157**	0.618***	0.673***	0.144**
	(10.54)	(11.67)	(2.50)	(10.42)	(11.57)	(2.25)
Number of observations	2,384	2,384	2,384	2,384	2,384	2,384
Number of banks	418	418	418	418	418	418
F-test	233.6	248.6	24.7	201.4	176.7	24.8
Hansen test (p-value)	0.277	0.222	0.102	0.447	0.216	0.114
AR1 (p-value)	0	0	0	0	0	0
AR2 (p-value)	0.383	0.208	0.364	0.391	0.219	0.426
AR3 (p-value)	0.878	0.387	0.558	0.895	0.398	0.564
			Long-run coefficients			
		$D^L \times LB^S$			$D^L \times LB^O$	
Interaction term	-1.31**	-1.84***	0.05	-0.11	-0.40	0.01
LB^S	5.69***	2.62**	0.30***	5.29***	2.23*	0.30***
LB^O	1.70***	0.66**	0.05***	1.75***	0.79**	0.05**
L_{t-1}	-0.45***	-0.49***	-0.01***	-0.48***	-0.47***	-0.01
ΔL	-0.83***	-0.64***	-0.01	-0.86***	-0.67***	-0.01
$\log(SIZE_{t-1})$	-4.52***	-3.32***	-0.24***	-4.61***	-3.49***	-0.23***
IB_{t-1}	-3.70**	-4.04**	-0.21***	-3.93**	-4.34**	-0.20**
IM	0.56	-0.47	0.23***	0.52	-0.26	0.24***
Δi	-0.06***	0.03	-0.01***	-0.06***	0.03	-0.01***
ΔGDP	-1.29**	-3.37***	0.27***	-1.28**	-3.48***	0.27***

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