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## Insights on Banks' Liquidity Management: Evidence from Regulatory Liquidity Data

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# Insights on Banks' Liquidity Management: Evidence from Regulatory Liquidity Data

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## Abstract

I investigate how banks manage liquidity as specified in the German prudential liquidity regulation, which combines a stock and cash-flow mapping approach. To do so, I use dynamic panel data regressions, take into account that payment obligations are endogenous and test whether banks whose liquidity is already close to the regulatory threshold purchase additional liquidity, more intensively match their cash inflows and outflows, or whether they perform an asset-side accounting exchange by decreasing illiquid assets, such as new long-term loans, and increasing liquid assets. The results suggest that commercial banks rely more intensively on markets when managing their liquidity, while savings and cooperative banks focus more on matching their cash inflows and outflows. Banks of all three types, except large commercial banks, also perform asset-side accounting exchanges and reduce their new long-term loans more when they need more liquid assets.

*Keywords:* Prudential liquidity regulation, payment obligations, long-term loans.

*JEL-Classification:* G21, G32

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## 1 Introduction

Long before the recent subprime crisis became a global crisis, regulatory authorities, under the influence of the Basel Committee for Banking Supervision, spent much effort on designing, harmonizing and implementing quantitative rules for prudential capital adequacy, but spent little effort on doing the same for liquidity. The crisis has changed this and has revived interest in liquidity regulations as a complement to solvency regulations (Rochet 2008), especially since high-capitalized banks may also suffer from funding liquidity strains in times of market turmoil. In a recent paper, the Basel Committee for Banking Supervision has outlined *principles for sound liquidity risk management and supervision* (Basel Committee 2008a). While in some countries, such as Italy and Spain, the liquidity regulations contain only qualitative requirements, in other countries, such as the United Kingdom and Germany, regulations specifying qualitative as well as quantitative requirements were installed several years ago (Algorithmics 2007). Qualitative requirements, which are often based on the recommendation of the Basel Committee (2000), focus, inter alia, on the need for adequate information systems, required processes to assess future cash-flows, net funding requirements, and setting of internal limits (Basel Committee 2008b). Quantitative requirements, which specify liquidity-relevant positions in simple rules, may be based on a stock approach that requires target holdings of liquid assets that can be drawn down, when needed and/or a cash-flow mapping approach that forces banks to match their cash in- and outflows. Both qualitative and quantitative requirements aim at limiting banks' exposure to funding risk (i.e., the risk that the counterparties who supplied short-term funding will not roll over that funding and force banks to use other funding sources), and market liquidity risk (i.e., the risk that disruptions in securities markets may turn formerly liquid assets into illiquid assets). Such quantitative requirements are usually designed for normal market conditions, not for times of market turmoil when liquidity in the interbank or securities markets vanishes.

Recent studies have focused on various aspects of banks' liquidity management, such as the management of 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 transforming short-term liabilities into illiquid assets (Berger and Bouwman 2009). However, little is known on

how banks manage their overall liquidity that is their liquid assets given their bank-specific payment obligations, although several countries have installed quantitative requirements, which can serve as a description of banks' overall liquidity. This paper contributes to filling this gap. Examining liquidity management based on regulatory data requires admitting that quantitative liquidity requirements are very simplified rules as compared to the complexity that banks face when managing liquidity. Because liquidity management is, by any standard, very complex, as banks have plenty of adjustment strategies, regulatory liquidity data can only serve to identify some of the basic management strategies that banks employ. Nevertheless, inspecting regulatory liquidity data is important, because banks may be initiated to take too excessive liquidity risks not only when central banks act as a lender of last resort (e.g., Ratnovski 2009, Repullo 2005), but also when quantitative liquidity requirements are too lax to limit liquidity risks effectively.

In this paper, I investigate how banks manage the liquidity specified in the Regulation on the Liquidity of Institutions, which formulates quantitative requirements for financial institutions' liquidity in Germany. The current liquidity regulation requires banks to have a liquidity ratio (LR) at least equal to one. This ratio is obtained from dividing regulatorily specified liquid assets, such as securities holdings and repayments from loans within the next month, by regulatorily specified payment obligations, which contain, *inter alia*, regulatorily specified percentages of demand and savings deposits and the full amount of liabilities maturing within the next month. Thus, the liquidity regulation in Germany combines a stock approach, since securities traded on regular markets are classified as highly liquid assets, and a cash-flow mapping approach, since cash inflows and outflows from on- and off-balance-sheet assets and liabilities are used when calculating regulatory liquidity. Behind this regulation is the assumption that a solvent and profitable bank can ensure its middle- and long-term refunding (Deutsche Bundesbank 1999, pp 29), but that it may face the risk of liquidity shortages in the short-run (FBSO 1998).

While banks have, under normal market conditions, plenty of adjustment strategies at their disposal that they can employ to have higher liquid assets when they are subject to higher payment obligations, I focus on three stylized strategies only. First, they may increase their liquid assets by purchasing additional funds when they are subject to higher payment

obligations. Second, they may have higher loan repayments because they match cash flows of their illiquid assets and liabilities long before they are subject to higher payment obligations from maturing liabilities. Third, they may perform an asset-side accounting exchange at the time when they are subject to higher payment obligations. Here fore, banks decrease illiquid assets, such as long-term loans, and synchronously increase liquid assets. Several recent studies demonstrate that liquidity shortages impact on bank lending (e.g., Paravisini 2008, Loutskina and Strahan 2009, Khwaja and Mian 2008). For example, Loutskina and Strahan (2009) find evidence that banks with high costs of funding and low balance-sheet liquidity are less willing to approve mortgages that are hard to sell than banks with low costs of funding and high balance-sheet liquidity. Their evidence indicates that banks are not able to cushion corporate borrowers against bank-specific liquidity shortages.

Insights into banks' liquidity management strategies can only be gained indirectly since banks' liquidity purchases are not observable. The empirical analysis comes in three steps. First, I test whether banks prefer to adjust securities holdings when they are subject to higher payment obligations. Here fore they either purchase liquidity or perform an asset-side accounting exchange. Second, I test whether banks have higher repayments from loans when they are subject to higher payment obligations. Here fore they (most likely) match cash flows of their assets and liabilities. Third, I test whether banks grants less new long-term loans when they are subject to higher payment obligations which would indicate that banks perform an asset-side accounting exchange. I build the analysis on banks' liquidity specified in the Regulation on the Liquidity of Institutions, use quarterly data from the three types of German universal banks (commercial, savings, and cooperative banks) for 2000-2008, apply dynamic panel data regressions and take into account that banks determine their regulatory liquid assets and payment obligations simultaneously. Since the median German universal bank has double the amount of liquid assets than required for its payment obligations, not all German universal banks alike are forced to manage their liquidity. Rather, banks whose LRs are close to the regulatory threshold (close banks hereafter) are more likely to manage their liquidity than banks that have plenty of liquid assets relative to their payment obligations (nonclose banks hereafter). For example, when a close bank is subject to an increase in its payment obligations, its LR will

more likely fall, if it does not make any adjustments, below the regulatory threshold than the LR of a nonclose bank. Therefore, I distinguish between the adjustments of close and nonclose banks.

The key results of the analysis can be summarized as follows. First, when they are subject to higher payment obligations, close savings and cooperative banks have higher repayments from loans, while commercial banks have higher securities holdings, and these increases are higher than the ones that nonclose banks have. These results may suggest that commercial banks rely more intensively on markets and are therefore more exposed to market liquidity risks when they manage their liquidity, while savings and cooperative banks focus more on their cash inflows and outflows from illiquid assets and liabilities. Second, close commercial, savings and cooperative banks reduce their new long-term loans (which have a maturity of more than one year) more than nonclose banks when they have higher contemporaneous payment obligations indicating that all three types of banks use asset-side accounting exchanges when they face higher payment obligations. Third, the economic effects of contemporaneous payment obligations on commercial banks' long-term loans are, however, much smaller than the corresponding effects on securities holdings. This difference in economic effects suggests that commercial banks do not only perform an asset-side accounting exchange but that they also purchase liquidity when they are subject to higher payment obligations.

The remainder of this paper is organized as follows. Section 2 describes the basic structure of the prudential liquidity regulation in Germany and outlines stylized management strategies, especially on how long-term loans and regulatory liquidity are related. Section 3 presents the econometric model and the dataset. Section 4 presents the estimation results. Section 5 summarizes and concludes.

## **2      *The German liquidity regulation and management strategies***

### *2.1      Basic features of the liquidity regulation*

As of 2007, the liquidity regulation is delineated by the Regulation on the Liquidity of Institutions (*Liquiditätsverordnung*), while between 2000 and 2006 it was delineated by Principle II

(Grundsatz II). The opening clause (Section 10) of the Regulation on the Liquidity of Institutions expands on Principle II by allowing banks to use their own liquidity models that have to be approved by the regulator. The Standardized Approach (Sections 2-7) of the Regulation on the Liquidity of Institutions is basically identical to Principle II and requires banks, at the end of each month, to calculate and to report a liquidity ratio (LR) and three observation ratios for time bands: one to three months, three to six months, and six to twelve months.<sup>1</sup> Large banks with more complex business models are expected to use their own liquidity models to calculate and report on their liquidity, whereas smaller banks, which are to a large extent savings and cooperative banks, are expected to continue to report LRs. The LR is the quotient of regulatorily specified liquid assets and payment obligations callable within the next month (FBSO 1998). If the LR is at least one, the liquidity of a bank is deemed adequate.

The Standardized Approach, which combines a stock and cash flow mapping approach, specifies numerous on- and off-balance-sheet assets that are factored into the numerator of the LR. The regulator allows securities not declared as financial fixed assets that are admitted for trading on a regular market and covered debt securities irrespective of the underlying residual maturities to be included in the shortest time band of the banks' maturity ladders. Securities holdings are believed to be the most effective cushion against funding liquidity shortages in the short-run. Securities account for 14% of commercial banks', 18% of savings banks', and almost 32% of cooperative banks' regulatory liquid assets (see Table 1). Covered debt securities account for only about 6% of commercial banks', 15% of cooperative banks' and even more than 30% of savings banks' regulatory liquid assets. Repayments from loans within the next month to customers and credit institutions are also factored into the numerator of the LR. They contribute substantially to the size of regulatory liquid assets. 65% of commercial banks', 26% of savings banks', and 39% of cooperative banks' regulatory liquid assets are repayments from loans to customers and credit institutions. Off-balance-sheet assets, such as irrevocable lending commitments received by the banks, are not very important for savings and cooperative banks.

[Insert Table 1 about here]

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<sup>1</sup> The calculation procedure of the LR under Principle II and the Regulation on the Liquidity of Institutions are identical except for two new liquidity-relevant off-balance-sheet positions introduced in the Regulation on the Liquidity of Institutions.

Similarly, the Standardized Approach specifies numerous on- and off-balance-sheet payment obligations, such as regulatorily specified percentages 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. 10% of the liabilities due on demand to customers, 40% of the liabilities due on demand to credit institutions, 10% of savings deposits irrespective of the period of notice, and 100% of the liabilities maturing within the next month are factored into the denominator of the LR. Liabilities due on demand to customers are of a similar size for all the three types of banks, namely about 14% to 16% (see Table 1), while liabilities due on demand to credit institutions are of substantial magnitude only for commercial banks. Savings deposits account for a substantial share of payment obligations for savings and cooperative banks, while liabilities maturing within the next month to credit institutions are a sizeable position for commercial banks only. Off-balance-sheet liabilities, except undrawn irrevocable credit facilities, are not of a substantial magnitude in the payment obligations.

As with any single quantitative requirement applied to many entities, the requirement does not adequately address all the liquidity circumstances of each single bank. There are multiple reasons for this. The regulatory authorities have to classify which on- and off-balance-sheet assets will be approved as liquid assets in the regulation. This classification is difficult, especially when market liquidity for single securities or whole market segments can vanish in a rather short time, for example, because investors herd the market. Even more important than classifying liquid assets is specifying how to value liquid assets. Using market values may induce particular forms of bank behavior not necessarily in line with the intentions of regulatory authorities. For example, valuing assets marked-to-market induces bank behavior that results in leverage that is strongly pro-cyclical (Adrian and Shin 2009). For liquidity purposes, market values of securities bear the danger that the bank may not realize this value in a short time, for example, because the securities' market liquidity is insufficient. Placing the full position of a bank's securities instantly in the market might come at large discounts to the initially assumed market value of the position. Haircuts might therefore be applied to the recently observed market values. In a similar vein, the regulatory authorities have to classify on- and off-balance-



sheet payment obligations and they have to specify call probabilities of liabilities due on demand. In the Standardized Approach, irrevocable lending commitments but not potential payment obligations from options and swaps are factored into the denominator of the LR. As regards call probabilities, 40% of the liabilities due on demand to credit institutions are factored into the denominator. Since call probabilities likely depend on market conditions and investor behavior, the regulatory authorities are required to inspect developments in markets and investor behavior carefully in order to take account of recent developments when amending simple quantitative rules.

## 2.2 *Liquidity management strategies*

To gain insights into banks' liquidity management strategies, I build my analysis on regulatory liquidity which is presumable correlated with banks' internal liquidity for which, however direct measures are not available. Banks' regulatory liquidity may only imperfectly describe the unknown internal liquidity since the internal liquidity is likely to be determined by many more factors than specified by the prudential liquidity regulation. Nevertheless, the banks' adjustments in regulatory liquidity give useful insights on the liquidity management strategies used. The reason for this is that banks will aim at meeting the requirement specified by the prudential liquidity regulation because when they fail to do so the regulator intervenes<sup>2</sup> and bank managers either loose control of their banking operations or are restricted in conducting them.

Starting point for investigating banks' liquidity management strategies is a simplified LR which is depicted at time  $t$  as follows:

$$LR_t = (LA_t^S + LA_{t|t+1}^R) / (PO_t^D + PO_{t|t+1}^M), \quad (1)$$

where  $LA_t^S$  denotes securities holdings at time  $t$ ,  $LA_{t|t+1}^R$  denotes expected loan repayments between  $t$  and  $t+1$ ,  $PO_t^D$  denotes liabilities that are factored into the denominator of the LR with a weighting of less than 100% (sight and savings deposits, interbank liabilities due on demand),

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<sup>2</sup> 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.

and  $PO_{t,t+1}^M$  denotes liabilities maturing between  $t$  and  $t+1$  that are factored into the denominator of the LR with a weighting of 100%.

I focus on three stylized liquidity management strategies: *liquidity purchases*, *matching cash flows from illiquid assets and liabilities*, and *asset-side accounting exchanges*. For a liquidity purchase Figure 1, Panel a, illustrates the sequence of events. Assume a bank whose LR is equal to the regulatory threshold at time 0. Before reporting its LR to the regulator at time 0, the bank does not need to make any adjustments, but it has to increase its regulatory liquid assets at time 1. The bank faces no payment obligations from maturing liabilities between time 0 and 1, but between time 1 and 2, i.e.,  $PO_{01}^M = 0$  and  $PO_{12}^M > 0$ . To meet the regulatory threshold at time 1, the bank has to raise additional funding (for doing so many different ways are available, see Chaplin et al. 2000). This additional funding must not mature within the next month, since otherwise 100% of this additional funding is factored into the denominator of the LR. Thus, the bank may either raise additional medium- or long-term funding or savings or sights deposits whose weighting in the denominator of the LR is less than 100%. This strategy requires that the bank refinances its liabilities up to one month in advance and the bank might, therefore, incur non negligible costs. Such liquidity purchase implies that the bank's liquidity management is more dependent from developments of financial markets which determine the conditions at which the bank can raise additional funding. It does not matter much whether the bank invests the additional funding into additional securities and values these at market prices, or whether it grants additional loans that are due on demand or mature within the next month. The reason for this is that the bank's regulatory liquid assets increase by 1 unit when it increases securities and repayments from loans within the next month by 1 unit. However, the costs associated with increasing the different types of regulatory liquid assets may differ, so that the bank may prefer a particular form of increasing its liquid assets over others. This leads to my hypothesis.

*Hypothesis 1:* Purchasing liquidity would imply that higher payment obligations come along with higher securities holdings and/or loan repayments. The bank would not change its illiquid assets.

[Insert Figure 1 about here]

In Figure 1, Panel b, the bank matches the cash flows of assets and liabilities and therefore it will have additional repayments from loans, i.e.,  $\Delta LA_{1|2}^R > 0$ , that outweigh the higher payment obligations from maturing liabilities. In some cases, the bank might not need to make further adjustments in the month before liabilities mature to keep its LR above the regulatory threshold. However, when the additional repayments from loans are not sufficient to outweigh the higher payment obligations from maturing liabilities, the bank needs to adjust its regulatory liquid assets before it reports the LR to the regulator.

*Hypothesis 2:* Matching cash flows of assets and liabilities would imply that higher payment obligations come along with higher loan repayments. The bank would not change its illiquid assets.

An asset-side accounting exchange is one possibility how the bank can increase its liquid assets when it has higher payment obligations at time 1.<sup>3</sup> The bank reduces new illiquid assets by granting less new long-term loans and/or securitizing long-term loans in order to increase regulatory liquid assets. Reducing long-term loans implies that the bank changes its degree of term and liquidity transformation, which might not be in the interest of the bank. As illustrated in Figure 1, Panel c, the bank can finance additional long-term loans when its maturing liabilities have been refinanced with liabilities not maturing within the next month so that its payment obligations are again at a lower level. Then, the bank would have excess regulatory liquid assets relative to its payment obligations and it may perform a second asset-side accounting exchange by increasing long-term loans and reducing either securities or loans due on demand. Thus, after some time has passed, the bank may offset the negative effect of contemporaneous increases in payment obligations on long-term loans.

*Hypothesis 3:* An asset-side accounting exchange would imply that higher contemporaneous payment obligations come along with a reduction in illiquid assets, while higher payment

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<sup>3</sup> There are two further adjustment strategies. First, the bank can increase its irrevocable lending commitments received from other institutions. When maturing liabilities are not rolled over, these commitments may have to be used to replace maturing liabilities. Thus, the bank would be prepared for the event that it fails to roll over its maturing liabilities. Second, the bank can do an accounting exchange on the liability side. It would reduce liabilities factored into and increase liabilities not factored into the denominator of the LR. For example, it can substitute medium-term interbank liabilities, which are not factored into the payment obligations, for demand deposits received from credit institutions, which are factored into the payment obligations.

obligations in the previous period come along with an increase in illiquid assets, such as long-term loans.

### 3 The econometric model and data

#### 3.1 The econometric model

I employ reduced-form models for the growth rates in loan repayments, securities, and long-term loans. Growth rates of the variables are used to avoid spurious correlations between the variables (e.g., Gambacorta and Mistrulli 2004). I use quarterly data, which allow dynamic responses in liquidity to be taken into account and which are not as noisy as monthly data. All my models have three common features: they all rely on the closeness of the banks' LR to the regulatory threshold, they are set up to capture dynamic responses, and they suffer from the endogeneity of the RHS variables. The underlying model can be outlined as follows:

$$\Delta y_{i,t} = \sum_{k=1}^4 \alpha_{k,1} \Delta y_{i,t-k} + \sum_{k=0}^1 \alpha_{k,2} \Delta PO_{i,t-k} + \sum_{k=0}^1 \alpha_{k,3} Close_{i,t-k} \Delta PO_{i,t-k} + \Gamma \Phi_{i,t-1} + \varepsilon_{i,t}$$

*with*  $\Delta y_{i,t} = \log(y_{i,t}) - \log(y_{i,t-1})$  , (2)

$\varepsilon_{i,t} = \mu_i + \eta_{i,t}$ ,

$i = 1, \dots, N$  ( $N = \text{number of banks}$ ) and  $t = 1, \dots, T$  ( $t = \text{quarters}$ )

where  $\Delta y_{it}$  denotes the growth rate of the dependent variable of bank  $i$  in quarter  $t$ ,  $\Delta PO_{it}$  denotes the growth rate of payment obligations of bank  $i$  in quarter  $t$ , and  $Close_{it}$  denotes a dummy variable for bank  $i$  in quarter  $t$ , which is equal to one when the bank's LR is close to the threshold. I follow Gambacorta and Mistrulli (2004), among others, and include 4 lags of the dependent variable to obtain white noise residuals. I include the contemporaneous and the lagged growth rate of payment obligations and experiment with further lags in the robustness section. I use payment obligations, and not payment obligations from maturing liabilities (which I use in robustness tests), since maturing liabilities may be offset by liabilities that are due on demand. To test the banks' adjustment behavior in regulatory liquidity reflected in the time variation of the data and not in the cross-sectional variation, I model a bank-specific fixed effect,  $\mu_i$ , and an iid disturbance term,  $\eta_{i,t}$ .

The dummy variable, *Close*, allows me to gain insights into whether banks closer to the regulatory threshold manage their regulatory liquidity more intensively than banks far away from the threshold. A similar approach has been used by studies dealing with the effectiveness of prudential capital regulations (e.g., Shrieves and Dahl 1992, Jacques and Nigro 1997, Aggarwal and Jacques 2001, Rime 2001, and Heid et al. 2004). These studies analyze whether banks whose ratios of capital to risk-weighted assets are deemed either as not regulatorily adequate (e.g., Shrieves and Dahl 1992) or as close but still above the regulatory threshold (e.g., Heid et al. 2004) differ in their behavior from nonclose banks. While such a dummy variable is expected to give insights into banks' management of liquidity, it does not allow identifying whether the adjustments of close banks results from the prudential regulation.

I define close banks as those banks whose LRs are close to, but still above, the regulatory threshold because the 5th-percentile LR, which varies rather little over time, always exceeds the regulatory threshold (see Figure 2). The median LR of commercial and cooperative banks is just about 2, which implies the median bank has double the amount of liquid assets than required for its payment obligations. The median LR of savings banks is even higher, more than 2.5. Therefore, I set the time-variant dummy variable, *Close*, equal to one when the bank's LR is lower than the 30th percentile of all the LRs of banks of the same type, and zero otherwise. I experiment with alternative definitions in the robustness section.

[Insert Figure 2 about here]

The coefficients of the payment obligations, especially the coefficients of the interaction terms (close bank  $\times$  growth rate of payment obligations), are central to the analysis. These variables are, however, not exogenous because banks determine their assets and payment obligations simultaneously. Therefore, I use two sets of instruments. First, I employ the long-term debt ratio, which is expected to be correlated with the growth rate of payment obligations, while it is, at least in a Modigliani-Miller world, uncorrelated with the growth rate of liquid assets. To check whether the long-term debt ratio is a powerful instrument for payment obligations, I run panel estimations for the growth rates of liquid assets and payment obligations. While the long-term debt ratio does not significantly impact on the growth rate of liquid assets, it is a significant

determinant of the growth rate of payment obligations: t-values are often well above 5. Second, I use lagged values of payment obligations as instruments. While lagged values are readily available for payment obligations, finding appropriate instruments to instrumentalize the interaction term is more difficult. When the dummy variable equal to one for close banks is time-variant, as it is in my analyses, a bank may be classified as being close to the threshold in the current, but not in the previous period. If the interaction term is instrumented with its past values, a non-zero value of the interaction term in the current period would be instrumented with its zero value in the previous period. An appropriate instrument for the interaction term is to use the past value of the interaction term when the bank under consideration was in the same state of nature, i.e., when the value of the interaction term of the close bank in the current period is instrumented with the value of the interaction term when the bank under consideration was also close to the regulatory threshold. This approach, which I employ, has been recently introduced by Kalkreuth (2008).

The matrix of control variables,  $\Phi_{it-1}$ , contains bank-specific characteristics adopted from the literature dealing with optimal cash holdings of corporate firms, such as bank size, interest margins, and regulatory capital, and quarterly and annual dummy variables. To avoid an endogeneity bias, I use lagged values of the bank-specific characteristics (e.g., Kashyap and Stein 2000). Bank size, measured by the logarithm of banks' total assets, matters for liquid assets and long-term loans for several reasons. Large banks use more wholesale funding (inter alia money market instruments), which is more volatile than traditional funding sources (Basel Committee 2008a), and/or they use more irrevocable credit commitments received from other institutions to manage their liquidity. Large banks are more likely to be active in the interbank market in order to be protected against imperfectly correlated liquidity shortages than small banks (Rochet and Tirole 1996), and they have better access to international capital markets than small banks (Cocco et al. 2009). Finally, the business models of large banks, especially of large commercial banks are more complex since they use originate-to-distribute models. The interest margin is included, since it measures the banks' opportunity costs of holding liquid assets in terms of forgone higher returns from loans (e.g., Aspachs et al. 2005). For capital, it is argued that high-capitalized banks can easier absorb unexpected losses and support

unanticipated asset growth more easily than low-capitalized banks. Moreover, high-capitalized banks may raise funds at a lower cost than low-capitalized banks, as capital absorbs risks and expands a bank's risk-bearing capacity (e.g., Bhattacharya and Thakor 1993, Repullo 2004).

The models are estimated for each type of bank separately. This is reasonable since banks belonging to different pillars of the German universal banking system fundamentally differ in their ownership structures and business objectives. While commercial and cooperative banks are privately owned, most savings banks belong to the state or local communities. Savings banks but not commercial and cooperative banks have a public mandate and benefited from a government guarantee in the past (Brunner et al. 2004). Irrespective of the government guarantee, savings banks have to meet the same regulatory requirements as cooperative and commercial banks. Because of their ownership structure, savings banks may have lower incentives to generate income from term and liquidity transformation and may therefore be less in the need to manage their liquidity than commercial and cooperative banks. As regards their business objectives, savings and cooperative banks state social and/or regional development objectives, whereas commercial banks do not have such goals. Because of different business objectives, banks from the three different sectors differ in their risk attitudes and profiles (Altunbas et al. 2007).

I estimate all the 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). The estimation results will be consistent if I use appropriate instruments for the lagged dependent variables and payment obligations, and if there is no second-order autocorrelation. Therefore, I use the Hansen test of overidentifying restrictions (Arellano and Bond 1991, Blundell and Bond 1998). Since the Hansen test of overidentifying restrictions can be weakened by many instruments (Roodman 2009), I specify only a very limited number of instruments. The same lag structure of instruments is used in all the estimations presented throughout the paper.

### 3.2 *The data*

The data on regulatory liquid assets and payment obligations have been taken from bank reports made under Principle II (2000-2006) and the Regulation on the Liquidity of Institutions (2007-2008). I take into account the changes in the liquidity regulation in 2007 and construct all variables as initially specified in Principle II so that the LR's are comparable over time. Table 2 provides descriptive statistics on regulatory liquid assets, payment obligations, and long-term loans of the three types of banks. It also provides results of two-sided tests on whether the variables for close and nonclose banks differ significantly. These test results help to understand why some banks are closer to the regulatory threshold than other banks. Irrespective of the bank type, close banks have significantly lower regulatory liquid assets and significantly higher payment obligations relative to their total assets than nonclose banks. Thus, close banks differ from nonclose banks in their asset as well as funding structures. Close banks invest less often in liquid assets and they rely more intensively on the funding sources that are factored into the payment obligations with a high weighting, such as liabilities maturing within the next month. Also, close banks have a higher share of long-term loans (i.e., loans with a maturity of more than 1 year) than nonclose banks regardless of the bank type, albeit the difference is not significant for commercial banks.

[Insert Table 2 about here]

Close and nonclose banks do also differ in the growth rates of securities, loan repayments and long-term loans. While the growth rates of securities and long-term loans do not differ significantly between close and nonclose commercial banks, the growth rates of loan repayments are significantly lower for close commercial banks than for nonclose commercial banks. Close savings banks have lower growth rates of securities and long-term loans than nonclose savings banks, while the growth rate of loan repayments does not differ between close and nonclose savings banks. Close cooperative banks have lower growth rates of securities and loan repayments, but higher growth rates of long-term loans than nonclose cooperative banks.



Table 2 also provides descriptive statistics for the growth rates of payment obligations and my control variables. The growth rates of payment obligations are significantly higher for close than for nonclose banks for all three types of banks. This underlines the necessity for close banks to make adjustments in their liquid assets. Close banks are significantly larger in terms of total assets, and they have significantly lower regulatory capital than nonclose banks. Close commercial and savings banks have significantly lower interest margins, while close cooperative banks have significantly higher interest margins than nonclose cooperative banks. Close commercial and savings banks have significantly lower loan-loss provisions than nonclose banks. Close savings and cooperative banks have significantly higher long-term debt ratios than nonclose banks.

For the empirical analyses, I transform the dataset as follows: I correct the dataset for outliers by removing those observations that are extraordinarily high. I normalize all size-sensitive variables by total assets and interpolate all variables which are available on an annual basis only, i.e., the interest margin and loan-loss provisions. The definitions and sources of variables are provided in Appendix A.

## **4 Estimation results**

### *4.1 Adjustments in securities and loan repayments*

Table 3 gives the estimation results on whether growth rates of securities (Panel a) and/or loan repayments (Panel b) increase in the growth rate of payment obligations, and whether the increases are stronger for close banks than for nonclose banks. Securities holdings of the three types of banks respond differently to increases in payment obligations (Panel a of Table 3). The contemporaneous growth rate of payment obligations has a positive effect for all three types of banks, albeit it lacks statistical significance for commercial banks. The interaction term coefficients for savings and cooperative banks are insignificant, indicating that these banks do not use securities more intensively than nonclose banks to manage their liquidity needs. However, close commercial banks' securities increase more intensively in response to increases in payment obligations than the ones of nonclose commercial banks. A one percent

increase in contemporaneous payment obligations based on the short-run coefficients, which is only significant at the 15%-level, leads to an additional increase of almost 0.20 percent in securities.

These results suggest that close commercial banks actively increase their securities more than nonclose commercial banks when payment obligations increase. They can reach such an active increase in their securities holdings either by purchasing liquidity or by an asset-side accounting exchange. Irrespective of whether they purchase liquidity, the results suggest that financial markets play a larger role in the liquidity management of commercial banks than of savings and cooperative banks. Therefore, adverse developments in financial markets more likely impact on commercial banks' liquidity, and, if banks purchase liquidity, this might create strong correlations between market and refunding risks.

[Insert Table 3 about here]

Loan repayments of the three types of banks also respond differently to increases in payment obligations (Table 3, Panel b). The coefficients of the contemporaneous growth rate of payment obligations, in one model also the lagged growth rate of payment obligations, are positive and significant for all three types of banks. These estimates imply that a one percent increase in payment obligations leads to a 0.18 to 0.26 percent increase, depending on the bank type, in loan repayments. The interaction term coefficients (close bank  $\times$  contemporaneous growth rate of payment obligations) are positive and statistically significant for close savings and cooperative banks: a one percent increase in payment obligations leads to an additional increase of 0.20 percent in loan repayments. The interaction term coefficient for close commercial banks is also positive but lacks statistical significance. The economic effects calculated from short-run coefficients are quite remarkable: A one-standard deviation increase in the contemporaneous growth rate of payment obligations increases nonclose savings and cooperative banks' loan repayments by 16% and 8%, respectively, while it increases close savings and cooperative banks' loan repayments by 30% and 18%, respectively. The economic effects calculated from long-run coefficients are lower than the ones calculated from short-run

coefficients indicating that banks start to adjust their loan repayments before the period in which they are subject to higher payment obligations.

Unfortunately, the above results on repayments from loans do not give direct insights on whether banks match cash flows of assets and liabilities. The reason here fore is that the repayments from loans cover quite different types of repayments some of which banks can always influence. By granting additional loans to credit institutions which are either due on demand, or have an initial maturity of not more than one month, banks can easily increase repayments from loans approved as regulatory liquid assets. Here fore they would purchase liquidity or perform an asset-side accounting exchange. Such pronounced increases in repayments from loans approved as regulatory liquid assets are not possible if banks grant additional loans to customers because these loans usually have initial maturities of much more than one month. In unreported regression, I therefore re-run the estimations of Table 3, Panel b, for repayments from loans to customers. The effects of contemporaneous payment obligations on repayments from loans in these estimations are a bit smaller but nicely match the findings discussed above. These results indicate that close savings and cooperative banks previously managed cash flows of assets and liabilities such that they could make higher payment obligations stemming from maturing liabilities match repayments from initially illiquid loans. Therefore, I conclude that close savings and cooperative banks are very differently prepared for higher payment obligations than close commercial banks.

#### *4.2 Adjustments in long-term loans*

In the following I investigate how long-term loans respond to the growth rate of payment obligations. If close banks change the composition of new loans to meet the regulatory liquidity requirement, the interaction term coefficient (close bank  $\times$  contemporaneous growth rate of payment obligations) will impact on new long-term loans negatively. If close banks offset this effect after some time, the interaction term coefficients (close bank  $\times$  lagged growth rate of payment obligations) will impact on new long-term loans positively.

Table 4 presents estimation results for long-term loans. The coefficients of the contemporaneous growth rate of payment obligations are negative and significant for savings

and cooperative banks. The estimates imply that a one percent increase in payment obligations leads to a reduction in savings and cooperative banks' long-term loans of 0.05 to 0.07 percent. The interaction term coefficients are negative for all three types of banks, albeit the coefficient is insignificant for savings banks. A one percent increase in payment obligations leads to an additional reduction of 0.03 to 0.11 percent in close commercial and cooperative banks' long-term loans. The economic effects of the contemporaneous growth rates of payment obligations on long-term loans are moderate: a one-standard deviation increase leads to a reduction in new long-term loans of 7.3% for close commercial banks, almost 5% for close savings banks, and about 4% for close cooperative banks.

[Insert Table 4 about here]

The lagged growth rate of payment obligations also shapes the growth rate of long-term loans. The coefficients of the lagged growth rate of payment obligations are negative and significant for savings and cooperative banks. The interaction term coefficients of the lagged growth rate of payment obligations are positive and statistically significant for all three types of banks although the economic effects are not large: a one-standard deviation increase in the lagged growth rate of payment obligations leads to an increase in new long-term loans of almost 3% for close commercial banks, and less than 1% for close savings and cooperative banks. These estimates suggest that close banks do offset part of the negative effect of the contemporaneous growth rate of payment obligations on long-term loans after a quarter.

The moderate effects of payment obligations on long-term loans, together with the remarkable effects of payment obligations on securities holdings and repayments from loans presented in Table 3 support the view that close banks of the three types follow different strategies to manage their liquidity. The results suggest that commercial banks use liquidity purchases, while savings and cooperative banks use matching cash flows of assets and liabilities so that large amounts of payment obligations payable in the near future go hand in hand with large amounts of initially illiquid assets maturing within the near future. Additionally, banks of all three types perform asset-side accounting exchanges and here fore reduce their long-term loans when the contemporaneous growth rate of payment obligations increases.

### 4.3 *Size and capital effects*

The results presented in Table 4 suggest that close banks of all three types of banks perform asset-side accounting exchanges when they are subject to higher payment obligations. Such an asset-side accounting exchange is likely influenced by bank size and regulatory capital. Long-term loans of large banks may respond less to increases in payment obligations than long-term loans of small banks since large banks likely raise additional funds from more different sources than small banks. Long-term loans of low-capitalized banks may respond stronger to increases in payment obligations than long-term loans of high-capitalized banks since the conditions of raising additional funds depend on banks' capitalization. Therefore, I run subsample regressions for large banks and for low-capitalized banks. Table 5 provides insights on whether being close to the threshold specified by the liquidity regulation is equally likely for large and small banks and for low- and high-capitalized banks. The banks included in these subsamples are those banks whose average size or regulatory capital is either below the 25th percentile or above the 75th percentile of the bank type sample. For all three types of banks, fewer small than large banks are classified as being close to the threshold. The difference is most pronounced for commercial banks: 52% of the observations for large commercial banks but only 22% of the observations for small commercial banks are classified as being close to the threshold. For all three types of banks, the percentages of high-capitalized banks that are close to the threshold are lower than the corresponding percentages of low-capitalized banks. 41% to 47% of the observations for low-capitalized banks and 15% to 30% of the observations for high-capitalized banks are classified as being close to the regulatory liquidity threshold.

[Insert Table 5 about here]

The effects of payment obligations on long-term loans for large banks (Panel a of Table 6) differ in some respect from the results I gain for the full sample (Table 4). Most interesting are the results for commercial banks: large commercial banks' long-term loans do not respond to contemporaneous payment obligations (Panel a of Table 6), while close commercial banks' long-term loans decrease significantly more when payment obligations increase than long-term loans of nonclose commercial banks (Table 4) indicating that small and mid-sized commercial banks but not large commercial banks perform an asset-side accounting exchange when they

are subject to higher payment obligations. Close large savings banks' long-term loans decrease in contemporaneous payment obligations significantly more than the ones of nonclose large savings banks, while in the full sample this effect was not statistically significant. As in the full sample, close large cooperative banks' long-term loans decrease in contemporaneous payment obligations and increase in the lagged payment obligations.

[Insert Table 6 about here]

Also, low-capitalized banks' responses in long-term loans differ from the full sample (Panel b of Table 6). The response of low-capitalized close commercial banks does not differ from low-capitalized nonclose commercial banks with respect to contemporaneous increases in payment obligations. To the contrary, the response of savings and cooperative banks' long-term loans matches the prediction of the risk-absorption hypothesis. Close low-capitalized savings and cooperative banks' long-term loans decrease significantly more in the contemporaneous growth rate of payment obligations than long-term loans of nonclose low-capitalized savings and cooperative banks. These results, in comparison to the results in Table 4, may suggest that high-capitalized savings banks are not as much obligated to finance the increase in regulatory liquid assets internally by making an accounting exchange on the asset side.

#### 4.4 *Robustness checks*

My first robustness check deals with the definition of the dummy variable for close banks. In the results discussed so far, I set the time-variant dummy variable, *Close*, equal to one if the bank's LR is lower than the 30th percentile of all the LRs of banks of the same type, and zero otherwise. In addition to this definition, I employ the 25th percentile and the 35th percentile as alternative cutoff levels. My results stay qualitatively unchanged when I use these alternative definitions. Moreover, I also use a time-invariant specification of the dummy variable *close* for three alternative cutoff levels (the 25th, 30th, and 35th percentiles). Noteworthy, the time-invariant dummy variables and their time-variant counterparts are highly correlated. These positive correlations indicate that banks rarely switch their relative liquidity position, i.e., banks whose LRs are close to the threshold keep their liquidity close to the threshold over time.

My second robustness check deals with the payment obligation variables. Since the interaction term of the dummy variable for close banks and the growth rate of payment obligations is correlated with the growth rate of payment obligations (see Appendix B), I also employ models from which the interaction term is removed. Removing the interaction term changes neither the significance levels nor the signs of the coefficients of the growth rate of payment obligations. Moreover, since the contemporaneous growth rate of payment obligations is correlated with the lagged growth rate of payment obligations, I check whether including either the contemporaneous or the lagged growth rate of payment obligations separately influences the results. It turns out that the results are robust to this alteration as well. Finally, I check whether including additional lags of the growth rate of payment obligations has an impact on my results. Higher order lags of the growth rate of payment obligations turn out to be insignificant throughout.

As a third robustness check, I take a closer look at the circumstances under which higher payment obligations force the close bank to adjust its liquid assets. Two extreme scenarios may demonstrate these circumstances, which arise because payment obligations are factored into the denominator of the LR with various weightings. In the first scenario, demand deposits that are factored into the LR with a weighting of less than 100% increase, while other funding sources that do or do not mature within the next month stay unchanged. Then, the close bank decides how much of its additional deposits it will employ to purchase liquid assets and how much it will employ to finance illiquid assets. In this scenario, the close bank does not have to take further adjustments and can easily meet the regulatory requirement. This is because the denominator increases by 0.1 units when the close bank increases sight or savings deposits irrespective of the period of notice by 1 unit, and by 0.4 units when it increases interbank borrowing due on demand by 1 unit. With each unit of additional deposits, the close bank can increase the numerator of the LR by 1 unit at a maximum. In the second scenario, on the other hand, demand deposits stay unchanged and payment obligations due to maturing liabilities increase. To meet the regulatory requirement, the close bank has to purchase additional securities that are approved by the liquidity regulation and/or it has to have additional loans that are either due on demand (interbank lending) or mature within the next month. In this second

scenario, the close bank has to adjust its regulatory liquid assets. Therefore, I replace total payment obligations by payment obligations that consists of on-balance-sheet liabilities maturing within the next month and off-balance-sheet activities and re-run the models. It turns out that my results stay unchanged.

Fourth, I test whether my estimation results depend on the consolidation wave in the German banking industry that occurred during the sample period. Such a robustness check is necessary because banks involved in mergers and acquisitions may behave differently than banks not involved in mergers and acquisitions. Therefore, I check whether the results presented in Table 3 and 4, which are based on a dataset in which banks involved in merger and acquisitions are treated as three separate banks, are sensible to removing banks involved in mergers and acquisitions. Dropping the two pre-merger banks and the merged bank from the dataset results in a substantial information loss but it produces a balanced dataset, i.e., the number of observations over time is identical for each bank. While the number of commercial banks observed is too low to perform regressions without banks involved in mergers and acquisitions, this robustness check confirms the results reported in Table 3 and 4 for savings and cooperative banks.

Finally, I exclude the financial crisis period from the sample and re-run the models for the period 2000/09 to 2007/06. It turns out that the estimation results stay qualitatively unchanged.

## **5 Summary and concluding remarks**

The German prudential liquidity regulation requires banks to have a liquidity ratio of regulatorily specified liquid assets, such as securities and repayments from loans within the next month, to regulatorily specified payment obligations at least equal to one. To analyze how banks manage their liquid assets when they are subject to higher payment obligations as specified in the liquidity regulation, I used quarterly data from the three types of German universal banks for 2000 to 2008, applied dynamic panel data techniques, and took into account that banks determine their liquid assets and payment obligations simultaneously. Since the median liquidity ratio of German universal banks is about 2, which indicates that not all banks are pressured to manage their liquid assets when their payment obligations increase, I distinguished between



banks whose liquidity ratios are close to the regulatory threshold (close banks) and banks whose liquidity ratios are not close to the threshold (nonclose banks).

The results of this paper indicate that banks of the three different types use quite different management strategies. The results suggest that commercial banks rely more intensively on markets when managing their regulatory liquidity, while savings and cooperative banks focus more on matching cash flows of assets and liabilities. Close savings and cooperative banks do not only match cash flows of their assets and liabilities in such a way that higher payment obligations come along with higher payments from assets, but they also perform asset-side accounting exchanges and reduce their new long-term loans more than nonclose banks when they have higher contemporaneous payment obligations. Close cooperative banks actually do offset the negative effect of payment obligations on long-term loans. This is good news for regulatory authorities, since it indicates that close banks do not per se reduce their long-term loans more than nonclose banks when they are subject to higher payment obligations, but rather that close banks postpone granting long-term loans in time to have sufficient liquidity.

Furthermore, the results suggest that small commercial banks do reduce their long-term loans when they face higher payment obligations, while large close commercial banks do not. This result matches the reasoning of the Basel Committee: Large commercial banks need more sophisticated models to manage their liquidity effectively, since they rely more intensively on wholesale funding sources, are more likely to employ originate-to-distribute business models, and are more often connected to other domestic and foreign banks. The opening clause in the Regulation on the Liquidity of Institutions, which allows banks to use internal liquidity models also for reporting on regulatory liquidity, may initiate further technical developments, such as dynamic stochastic analytical methodologies. So far, however, it is an open question which banks will opt to use their internal liquidity models and whether these internal models are built on more sophisticated techniques that take into account the complexity of liquidity-relevant on- and off-balance-sheet positions. Irrespective of the opening clause, the majority of banks in Germany are too small to apply complex liquidity models in which call probabilities, hair cuts, and correlations to other types of risks might be estimated by the banks themselves.

Nevertheless, it must be kept in mind that simple rules allow banks a multitude of liquidity management strategies, which may be accompanied by different risks.

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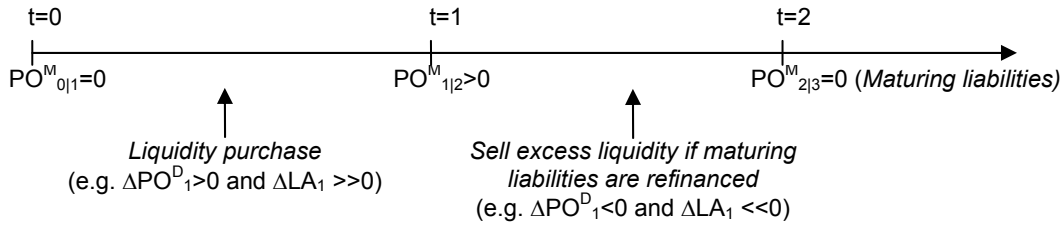
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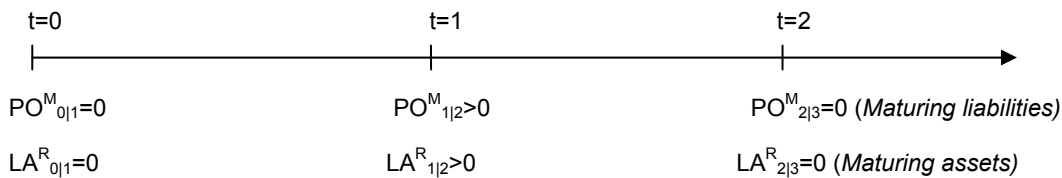
Figure 1

Adjustments in regulatory liquid assets

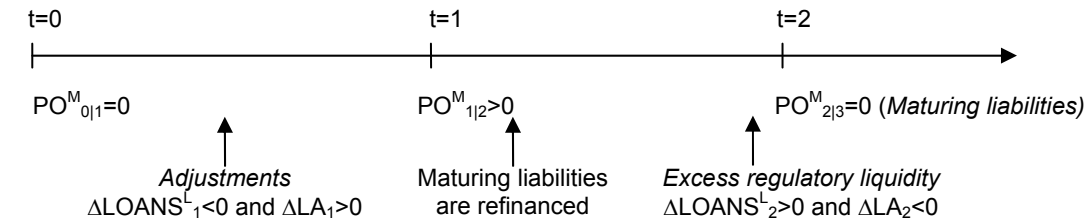
Panel (a): Liquidity purchase



Panel (b): Matching cash flows of assets and liabilities



Panel (c): Asset-side accounting exchange



Notes. Adjustments in regulatory liquid assets are necessary because the bank has liabilities that mature between time 1 and 2, so that the LR at time 1 would fall without further adjustments below the regulatory threshold. Panel (a) – the bank purchases liquidity some time before liabilities mature. Panel (b) – the bank matches cash flows of its assets and liabilities so that maturing liabilities comes along with more prepayments from initially illiquid assets. Panel (c) – the bank uses an asset-side account exchange. After adjusting its regulatory assets,  $LA_1$ , and after maturing liabilities were refinanced before time 2, the bank has excess regulatory liquidity, which it may use to grant additional long-term loans.

Figure 2

Liquidity ratios of German universal banks (quarterly data, 2000/09 to 2009/06)

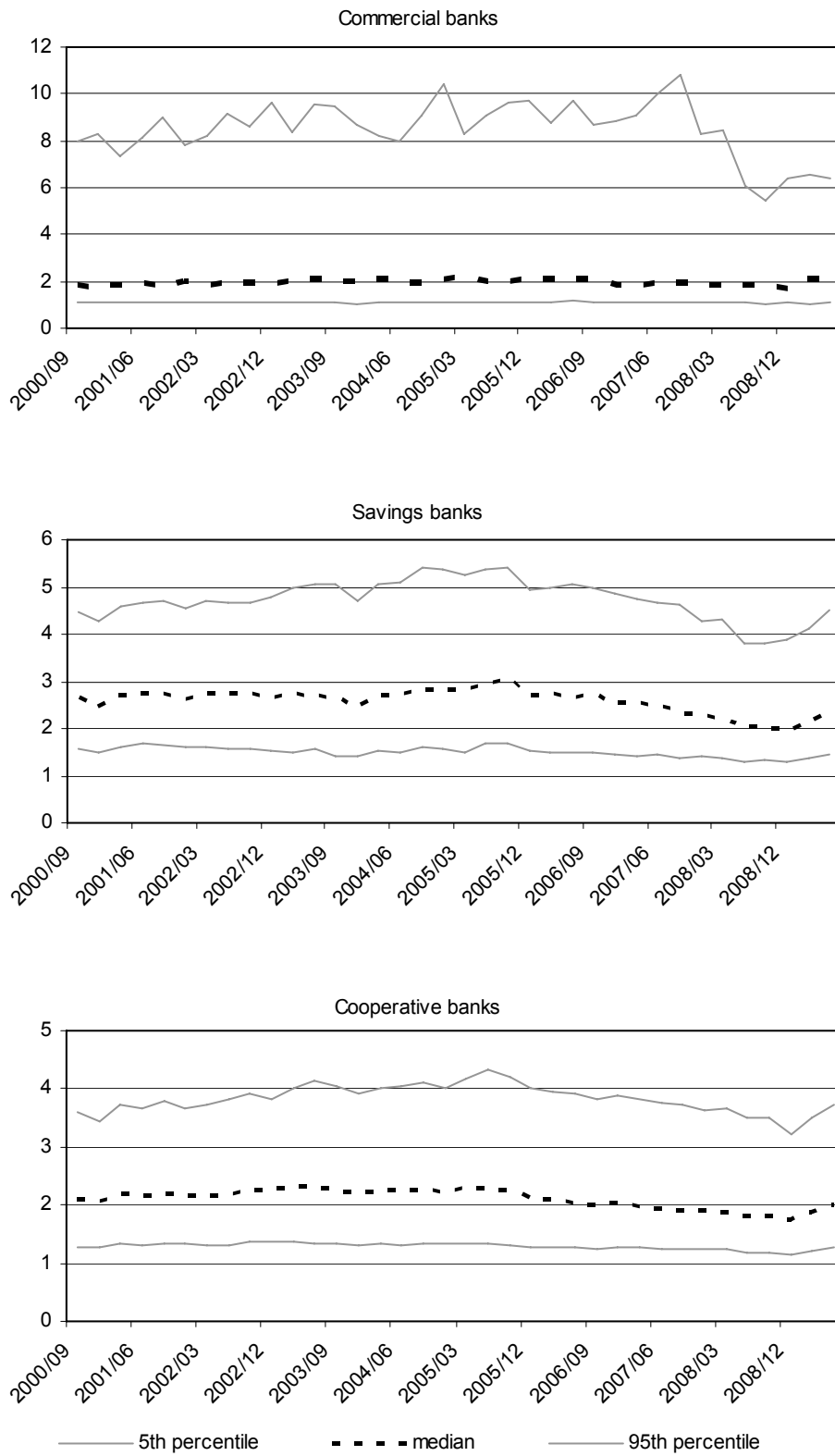




Table 1

## Main positions in German banks' liquidity ratios

	Commercial banks	Savings banks	Cooperative banks
<b>Liquid assets</b>			
Cash	1.05	2.00	3.02
Irrevocable lending commitments received by the institution	7.12	0.23	0.54
Securities not stated as financial fixed assets that are admitted for trading on a regular market	14.07	17.85	31.53
Covered debt securities	5.68	30.61	15.49
Shares in money market and securities funds	1.32	17.04	5.52
Loans and advances to credit institutions	36.66	10.02	18.57
Loans and advances to customers	28.92	16.02	20.60
<i>Coverage</i>	94.83	94.08	95.27
<b>Payment obligations</b>			
Demand liabilities to credit institutions	6.41	0.93	0.45
Demand liabilities to customers	14.05	16.09	14.88
Liabilities to credit institutions (maturing within the next month)	19.03	5.74	1.83
Liabilities to customers (maturing within the next month)	34.95	36.19	49.56
Savings deposits (irrespective of the period of notice)	3.81	27.62	25.46
Securitized liabilities	0.81	1.11	0.53
Undrawn irrevocably granted credit facilities	4.26	3.97	3.03
Other off-balance-sheet obligations	1.03	0.91	0.94
<i>Coverage</i>	84.35	92.59	96.68

*Notes.* Positions that belong to the liquid assets specified in the liquidity regulation are expressed in percent of the numerator of the ratio, and payment obligations are expressed in percent of the denominator of the ratio. Other off-balance-sheet payment obligations comprise 5% of contingent liabilities from rediscounted bills, guarantees and indemnity agreements, 5% of the liabilities from assets pledged as collateral for third-party liabilities, and 20% of placement and underwriting commitments.

Table 2  
Descriptive statistics

	Close banks		Nonclose banks		Equality test
	Mean	Standard deviation	Mean	Standard deviation	
<i>Commercial banks</i>					
Regulatory liquid assets	43.88	22.45	46.64	22.57	-3.01***
Regulatory payment obligations	35.46	19.47	20.40	12.12	21.64***
Long-term loans	36.53	25.48	34.89	25.47	1.57
Growth rate of securities	-1.10	87.38	-3.83	102.95	0.71
Growth rate of loan repayments	-6.95	71.22	0.91	68.53	-2.74***
Growth rate of long-term loans	-0.14	33.40	-1.33	35.35	0.85
Growth rate of payment obligations	10.12	57.32	-9.99	72.56	7.75***
Size	38,920.05	12,9761.10	3,152.27	8,854.79	8.56***
Interest margin	1.73	1.40	2.37	1.72	-10.08***
Regulatory capital	0.13	0.06	0.17	0.14	-9.53***
Loan-loss provisions	0.43	0.46	0.57	0.61	-6.48***
Long-term debt ratio	12.10	12.08	11.97	14.00	0.24
<i>Savings banks</i>					
Regulatory liquid assets	26.18	6.95	36.06	9.98	-64.99***
Regulatory payment obligations	15.01	3.89	11.45	2.75	52.12***
Long-term loans	59.68	9.30	51.32	11.62	43.71***
Growth rate of securities	-9.18	68.58	0.13	50.42	-7.68***
Growth rate of loan repayments	-4.66	129.09	-5.84	130.57	0.47
Growth rate of long-term loans	0.17	14.54	0.69	12.26	-1.97**
Growth rate of payment obligations	14.45	64.99	-6.43	60.08	23.26***
Size	2,691.07	3,507.81	1,729.42	2,155.97	15.97***
Interest margin	2.02	0.39	2.06	0.40	-4.61***
Regulatory capital	0.12	0.02	0.14	0.03	-27.84***
Loan-loss provisions	0.55	0.27	0.58	0.27	-4.85***
Long-term debt ratio	21.41	8.31	19.24	8.70	13.50***
<i>Cooperative banks</i>					
Regulatory liquid assets	26.28	7.28	33.45	9.39	-77.33***
Regulatory payment obligations	17.88	4.95	13.17	3.63	88.14***
Long-term loans	61.18	9.31	56.08	9.95	46.16***
Growth rate of securities	-5.18	77.55	2.31	63.74	-8.75***
Growth rate of loan repayments	-12.31	108.26	-4.11	110.78	-6.48***
Growth rate of long-term loans	0.66	14.47	-0.39	14.03	6.29***
Growth rate of payment obligations	8.09	47.76	-4.02	47.32	21.89***
Size	478.22	1,742.32	385.91	715.89	5.27***
Interest margin	2.52	0.52	2.50	0.52	3.35***
Regulatory capital	0.13	0.03	0.14	0.04	-30.16***
Loan-loss provisions	0.52	0.35	0.52	0.33	0.03
Long-term debt ratio	15.79	6.64	15.46	6.77	4.23***

Notes. Close banks' LR's are close to the threshold specified by the regulator; nonclose banks' LR's are not close to the threshold. Equality tests are mean tests for equality with varying variances for close and nonclose banks. Total assets are in € million. For further data definitions, see Appendix A.

Table 3

## Adjustments in loan repayments and securities

## Panel (a) Growth rate of securities holdings

	Commercial banks	Savings banks	Cooperative banks
<i>Short-run coefficients</i>			
$\Delta$ payment obligations <sub>t</sub>	0.107 (0.081)	0.033** (0.016)	0.064*** (0.016)
$\Delta$ payment obligations <sub>t-1</sub>	0.049 (0.045)	0.024* (0.014)	0.028** (0.013)
Close <sub>t</sub> × $\Delta$ payment obligations <sub>t</sub>	0.198 (0.128)	-0.004 (0.029)	-0.045 (0.033)
Close <sub>t-1</sub> × $\Delta$ payment obligations <sub>t-1</sub>	0.187** (0.088)	-0.005 (0.024)	0.02 (0.031)
log(assets <sub>t-1</sub> )	1.248 (1.092)	0.932* (0.538)	0.524 (0.378)
Interest margin <sub>t-1</sub>	-1.165 (1.420)	-1.342 (1.126)	-2.869*** (0.984)
Regulatory capital <sub>t-1</sub>	-9.622 (13.728)	32.238* (18.120)	9.832 (11.173)
Number of observations	2,481	12,698	33,963
Number of banks	139	515	1,445
F test	9.49	9.88	22.24
Hansen test (p-value)	0.853	0.129	0.435
Number of instruments	26	26	26
AR1 (p-value)	0	0	0
AR2 (p-value)	0.449	0.085	0.059
<i>Long-run coefficients</i>			
$\Delta$ payment obligations <sub>t</sub>	0.071 (0.053)	0.023** (0.011)	0.048*** (0.012)
$\Delta$ payment obligations <sub>t-1</sub>	0.032 (0.029)	0.017* (0.009)	0.021** (0.010)
Close <sub>t</sub> × $\Delta$ payment obligations <sub>t</sub>	0.131 (0.088)	-0.003 (0.020)	-0.034 (0.024)
Close <sub>t-1</sub> × $\Delta$ payment obligations <sub>t-1</sub>	0.124** (0.061)	-0.004 (0.017)	0.015 (0.024)

Panel (b) Growth rate of loan repayments

	Commercial banks	Savings banks	Cooperative banks
<i>Short-run coefficients</i>			
$\Delta\text{payment obligations}_t$	0.196*** (0.050)	0.257*** (0.039)	0.179*** (0.028)
$\Delta\text{payment obligations}_{t-1}$	0.046* (0.025)	-0.01 (0.031)	0.023 (0.023)
$\text{Close}_t \times \Delta\text{payment obligations}_t$	0.093 (0.082)	0.221*** (0.062)	0.188*** (0.045)
$\text{Close}_{t-1} \times \Delta\text{payment obligations}_{t-1}$	-0.012 (0.052)	0.004 (0.050)	-0.057 (0.047)
$\log(\text{assets}_{t-1})$	0.804 (0.781)	-0.825 (0.636)	-1.998*** (0.368)
Interest margin $_{t-1}$	0.524 (1.039)	1.846 (1.947)	1.697 (1.120)
Regulatory capital $_{t-1}$	-11.881 (7.684)	31.09 (27.271)	-36.514*** (12.689)
Number of observations	2,481	12,698	33,963
Number of banks	139	515	1,445
F test	24.32	76.99	150.93
Hansen test (p-value)	0.045	0.111	0.243
Number of instruments	26	26	26
AR1 (p-value)	0	0	0
AR2 (p-value)	0.127	0.265	0.134
<i>Long-run coefficients</i>			
$\Delta\text{payment obligations}_t$	0.108*** (0.031)	0.152*** (0.024)	0.100*** (0.016)
$\Delta\text{payment obligations}_{t-1}$	0.025* (0.014)	-0.006 (0.018)	0.013 (0.0128)
$\text{Close}_t \times \Delta\text{payment obligations}_t$	0.051 (0.045)	0.131*** (0.038)	0.105*** (0.025)
$\text{Close}_{t-1} \times \Delta\text{payment obligations}_{t-1}$	-0.006 (0.029)	0.002 (0.030)	-0.032 (0.026)

Notes. Estimation results on how the growth rate of payment obligations,  $\Delta\text{PO}$ , impact on the growth rate of repayments from loans,  $\Delta\text{LAR}$ , and securities holdings,  $\Delta\text{LAS}$ . Results from GMM estimations with Windmeijer's (2005) corrected standard errors in parentheses are derived from the following models:

$$\Delta\text{LA}_{i,t}^y = \sum_{k=1}^4 \alpha_{k,1}^y \Delta\text{LA}_{i,t-k}^y + \sum_{k=0}^1 \alpha_{k,2}^y \Delta\text{PO}_{i,t-k} + \sum_{k=0}^1 \alpha_{k,3}^y \text{Close}_{i,t-1} \Delta\text{PO}_{i,t-k} \\ \alpha_4^y \log(\text{assets}_{i,t-1}) + \alpha_5^y \text{IM}_{i,t-1} + \alpha_6^y \text{CAP}_{i,t-1} + \varepsilon_{i,t}^y \quad y \in \{R, S\}$$

Close denotes a dummy variable that equals one if the bank's LR is close to the regulatory threshold, IM denotes the interest margin, and CAP denotes regulatory capital.  $\Delta$  denotes the quarterly growth rate. The lagged values of the dependent variables and the growth rate of payment obligations are instrumented using past values and the long-term debt ratio. All models include quarterly and annual dummy variables. Coefficient estimates for the lagged values of the dependent variables and quarterly and annual dummy variables are not shown. \*, \*\*, \*\*\* denote statistical significance at the 10%, 5%, and 1% level.

Table 4  
Adjustments in long-term loans

	Commercial banks	Savings banks	Cooperative banks
<i>Short-run coefficients</i>			
$\Delta\text{payment obligations}_t$	0.040 (0.042)	-0.071*** (0.005)	-0.052*** (0.005)
$\Delta\text{payment obligations}_{t-1}$	0.010 (0.016)	-0.010*** (0.003)	-0.007** (0.004)
$\text{Close}_t \times \Delta\text{payment obligations}_t$	-0.107** (0.053)	-0.008 (0.008)	-0.030*** (0.007)
$\text{Close}_{t-1} \times \Delta\text{payment obligations}_{t-1}$	0.041 (0.026)	0.022*** (0.006)	0.014** (0.007)
$\log(\text{assets}_{t-1})$	0.964 (0.606)	0.274*** (0.100)	0.148* (0.082)
Interest margin <sub>t-1</sub>	2.182** (0.983)	-0.201 (0.290)	0.462** (0.235)
Regulatory capital <sub>t-1</sub>	-5.524 (12.215)	-19.378*** (4.262)	-11.356*** (3.189)
Loan-loss provision <sub>t-1</sub>	-4.352* (2.332)	-0.773* (0.445)	-1.607*** (0.269)
Observations	2,481	12,698	33,963
Number of banks	139	515	1,445
F test	2.41	80.16	120.42
Hansen test (p-value)	0.856	0.409	0.452
Number of instruments	26	26	26
AR1 (p-value)	0.021	0	0
AR2 (p-value)	0.702	0.328	0.108
<i>Long-run coefficients</i>			
$\Delta\text{payment obligations}_t$	0.030 (0.033)	-0.085*** (0.010)	-0.057*** (0.006)
$\Delta\text{payment obligations}_{t-1}$	0.007 (0.012)	-0.012*** (0.004)	-0.008** (0.004)
$\text{Close}_t \times \Delta\text{payment obligations}_t$	-0.080* (0.047)	-0.009 (0.009)	-0.033*** (0.008)
$\text{Close}_{t-1} \times \Delta\text{payment obligations}_{t-1}$	0.031 (0.021)	0.026*** (0.008)	0.015* (0.008)

Notes. Estimation results on how the growth rate of payment obligations,  $\Delta PO$ , impacts on the growth rate of long-term loans,  $\Delta LOANS^L$ . Results from GMM estimations with Windmeijer's (2005) corrected standard errors in parentheses are derived from the following dynamic panel-data model:

$$\Delta LOANS_{i,t}^L = \sum_{k=1}^4 \alpha_{k,1} \Delta LOANS_{i,t-k}^L + \sum_{k=0}^1 \alpha_{k,2} \Delta PO_{i,t-k} + \sum_{k=0}^1 \alpha_{k,3} \text{Close}_{i,t-k} \Delta PO_{i,t-k} + \alpha_4 \log(\text{assets}_{i,t-1}) + \alpha_5 \text{IM}_{i,t-1} + \alpha_6 \text{CAP}_{i,t-1} + \alpha_7 \text{LL}_{i,t-1} + \varepsilon_{i,t}$$

$\text{Close}$  denotes a dummy variable that equals one if the bank's LR is close to the regulatory threshold,  $\text{IM}$  denotes the interest margin,  $\text{CAP}$  denotes regulatory capital, and  $\text{LL}$  denotes loan-loss provisions.  $\Delta$  denotes the quarterly growth rate. The lagged values of the dependent variable and the growth rate of payment obligations are instrumented. All the models include quarterly and annual dummies. \*, \*\*, \*\*\* denote statistical significance at the 10%, 5%, and 1% level.

Table 5

Close banks and size and capitalization

	Commercial banks	Savings banks	Cooperative banks
Small banks	0.218	0.253	0.282
Large banks	0.526	0.409	0.305
High-capitalized banks	0.305	0.146	0.206
Low-capitalized banks	0.465	0.438	0.415

Notes. The numbers give the share of close-bank observations in various subsamples. Small (large) banks are those banks whose total assets are smaller (larger) than the 25th (75th) percentile of the bank type sample. Low- (high-) capitalized banks are those banks whose regulatory capital is smaller (larger) than the 25th (75th) percentile of the bank type sample.

Table 6

## Long-term loan adjustments for large and low-capitalized banks

*Panel a:* Selected long-run coefficients in subsamples of large banks

	Commercial banks	Savings banks	Cooperative banks
$\Delta$ payment obligations <sub>t</sub>	0.030 (0.050)	-0.081*** (0.019)	-0.062*** (0.012)
$\Delta$ payment obligations <sub>t-1</sub>	0.027 (0.030)	-0.008 (0.007)	-0.009 (0.005)
Close <sub>t</sub> × $\Delta$ payment obligations <sub>t</sub>	0.034 (0.071)	-0.031** (0.015)	-0.035*** (0.013)
Close <sub>t-1</sub> × $\Delta$ payment obligations <sub>t-1</sub>	0.122 (0.081)	0.010 (0.011)	0.028** (0.012)
Observations	859	4,312	11,504
Number of banks	54	187	527
F test	8.14	41.60	56.02
Hansen test (p-value)	0.817	0.197	0.341
Number of instruments	26	26	26
AR1 (p-value)	0.05	0	0
AR2 (p-value)	0.619	0.132	0.388

*Panel b:* Selected long-run coefficients in subsamples of low-capitalized banks

	Commercial banks	Savings banks	Cooperative banks
$\Delta$ payment obligations <sub>t</sub>	-0.011 (0.017)	-0.060*** (0.012)	-0.049*** (0.011)
$\Delta$ payment obligations <sub>t-1</sub>	-0.006 (0.009)	-0.009 (0.006)	0.005 (0.006)
Close <sub>t</sub> × $\Delta$ payment obligations <sub>t</sub>	0.006 (0.052)	-0.026** (0.011)	-0.039*** (0.012)
Close <sub>t-1</sub> × $\Delta$ payment obligations <sub>t-1</sub>	0.048 (0.030)	0.008 (0.009)	0.001 (0.011)
Observations	795	4,185	11,222
Number of banks	40	178	496
F test	5.86	38.17	45.06
Hansen test (p-value)	0.269	0.776	0.019
Number of instruments	26	26	26
AR1 (p-value)	0.005	0	0
AR2 (p-value)	0.37	0.338	0.192

Notes. Selected long-run coefficients on how the growth rate of payment obligations,  $\Delta PO$ , impacts on the growth rate of long-term loans,  $\Delta LOANS^L$ . The results from GMM estimations with Windmeijer's (2005) corrected standard errors in parentheses are derived from the following dynamic panel-data model:

$$\Delta LOANS_{i,t}^L = \sum_{k=1}^4 \alpha_{k,1} \Delta LOANS_{i,t-k}^L + \sum_{k=0}^1 \alpha_{k,2} \Delta PO_{i,t-k} + \sum_{k=0}^1 \alpha_{k,3} Close_{i,t-k} \Delta PO_{i,t-k} + \alpha_4 \log(\text{assets}_{i,t-1}) + \alpha_5 IM_{i,t-1} + \alpha_6 CAP_{i,t-1} + \alpha_7 LL_{i,t-1} + \varepsilon_{i,t}$$

Close denotes a dummy variable that equals one if the bank's LR is close to the regulatory threshold, IM denotes the interest margin, CAP denotes regulatory capital, and LL denotes loan-loss provisions.  $\Delta$  denotes the quarterly growth rates. The model is estimated for several subsamples separately. Panel a: large banks are those banks whose total assets are larger than the 75th percentile of the bank type sample. Panel b: low-capitalized banks are those banks whose regulatory capital is smaller than the 25th percentile of the bank type sample. The lagged values of the dependent variable and the growth rate of payment obligations are instrumented. All the models include quarterly and annual dummies. \*, \*\*, \*\*\* denote statistical significance at the 10%, 5%, and 1% level.



## Appendix A

### Data Definitions and Sources

#### *Regulatory liquid assets:*

Liquid assets contain, inter alia, regulatorily specified securities and repayments from loans normalized by total assets.

*Source:* Reports on Principle II (2000-2006) and the Regulation on the Liquidity of Institutions (2007-2008).

#### *Securities:*

Securities holdings consist of securities not stated as financial fixed assets that are admitted for trading on a regular market, debt securities, shares in money market and securities funds, and irrevocable lending commitments received by credit institutions normalized by total assets. Depending on the type of the security, market or book values are used.

*Source:* Reports on Principle II (2000-2006) and the Regulation on the Liquidity of Institutions (2007-2008).

#### *Loan repayments:*

Loan repayments consist of repayments from loans and advances within the next month normalized by total assets.

*Source:* Reports on Principle II (2000-2006) and the Regulation on the Liquidity of Institutions (2007-2008).

#### *Regulatory payment obligations:*

Payment obligations consist of regulatory-specified percentages of liabilities that are due on demand (10% of the sight deposits plus 40% of the demand deposits to credit institutions), 10% of the savings deposits (irrespective of the period of notice), liabilities that mature within the next month and payment obligations from off-balance-sheet activities normalized by total assets.

*Source:* Reports on Principle II (2000-2006) and the Regulation on the Liquidity of Institutions (2007-2008).

#### *Close bank:*

Dummy variable, which is equal to 1 if the bank is close to the threshold that the liquidity regulation specifies. A bank is classified as being close to the threshold when its LR in the quarter is lower than the 30th percentile of the bank type sample.

#### *Long-term loans:*

Loans to nonbanks and credit institutions with a maturity of more than one year normalized by total assets.

*Source:* Monthly balance-sheet statistics.

#### *Assets:*

Total assets in million €.

*Source:* Monthly balance-sheet statistics.

#### *IM*

Interest margin calculated as interests received minus the costs of funding normalized by total assets.

*Source:* Income statements.

#### *Capital*

Regulatory capital relative to risk-weighted assets.

*Source:* Reports on Principle I and Reports on Solvency Regulation.

#### *Loan-loss provisions*

Annual loan loss provisions divided by loans to non-banks.

*Source:* Income statements.

## Appendix B

### Correlations

<b>Commercial banks</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Growth rate of securities	1								
(2) Growth rate of loan repayments	-0.18*	1							
(3) Growth rate of payment obligations	0.07*	0.24*	1						
(4) Growth rate of long-term loans	-0.02	-0.26*	-0.15*	1					
(5) Size <sub>t-1</sub>	-0.01	0.01	-0.00	0.00	1				
(6) Interest margin <sub>t-1</sub>	-0.01	-0.01	-0.02	0.06*	-0.17*	1			
(7) Regulatory capital <sub>t-1</sub>	0.03	-0.01	-0.04*	-0.02	-0.06*	0.03*	1		
(8) Loan-loss provisions <sub>t-1</sub>	-0.02	-0.01	-0.01	0.00	-0.09*	0.50*	-0.13*	1	
(9) Close bank × growth rate of payment obligations	0.07*	0.22*	0.53*	-0.11*	-0.02	-0.02	-0.00	-0.03	1
(10) Close bank × growth rate of payment obligations <sub>t-1</sub>	-0.01	-0.09*	-0.18*	0.071*	-0.02	-0.03	-0.01	-0.03	-0.20*
<b>Savings banks</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)
(1) Growth rate of securities	1								
(2) Growth rate of loan repayments	-0.30*	1							
(3) Growth rate of payment obligations	0.02*	0.26*	1						
(4) Growth rate of long-term loans	-0.04*	-0.37*	-0.45*	1					
(5) Size <sub>t-1</sub>	-0.01	0.01	0.00	-0.00	1				
(6) Interest margin <sub>t-1</sub>	0.01	-0.00	-0.03*	0.02*	-0.24*	1			
(7) Regulatory capital <sub>t-1</sub>	0.01	-0.00	0.01	-0.03*	-0.06*	-0.02*	1		
(8) Loan-loss provisions <sub>t-1</sub>	-0.01	-0.00	-0.02*	0.01	-0.08*	0.24*	-0.15*	1	
(9) Close bank × growth rate of payment obligations	0.03*	0.19*	0.59*	-0.31*	0.01	-0.04*	-0.08	-0.03*	1
(10) Close bank × growth rate of payment obligations <sub>t-1</sub>	0.01	-0.13*	-0.28*	0.18*	0.00	-0.04*	-0.00	-0.02*	-0.23*
<b>Cooperative banks</b>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(10)
(1) Growth rate of securities	1								
(2) Growth rate of loan repayments	-0.36*	1							
(3) Growth rate of payment obligations	0.01*	0.19*	1						
(4) Growth rate of long-term loans	-0.03*	-0.40*	-0.27*	1					
(5) Size <sub>t-1</sub>	-0.01	-0.00	0.00	-0.01*	1				
(6) Interest margin <sub>t-1</sub>	-0.00	-0.01	-0.04*	0.06*	-0.29*	1			
(7) Regulatory capital <sub>t-1</sub>	0.01	-0.00	0.02*	-0.04*	-0.11*	0.02*	1		
(8) Loan-loss provisions <sub>t-1</sub>	0.00	0.00	-0.01*	-0.00	-0.02*	0.26*	-0.16*	1	
(9) Close bank × growth rate of payment obligations	0.01*	0.14*	0.56*	-0.20*	0.00	-0.03*	0.01*	-0.02*	1
(10) Close bank × growth rate of payment obligations <sub>t-1</sub>	0.04*	-0.09*	-0.25*	0.09*	0.00	-0.02*	0.00	-0.00	-0.24*

Notes. Correlation coefficients are for the variables used in the empirical analyses. For variable definitions, see Appendix A.