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Does the Eurosystem's lender of last resort facility has a structurally different option value across banks?

November 30, 2014

Abstract

Using a unique data set, we study whether structural bank characteristics can help to explain a bank's propensity to take recourse to the ECB's marginal lending facility (MLF). Our key finding is that structural measures capturing a bank's business model as well as structural characteristics its liquidity risk management such as volatile reserve holdings, a lower average reserve fulfillment and a more aggressive bidding behavior in the main refinancing operations have a highly significant predictive power for a bank's access to the lender-of-the-last-resort (LLR) facility. These results suggest that the option value of having access to the ECB's LLR varies fundamentally across banks. Banks with a business model that exposes them to larger liquidity risks benefit more from a uniform marginal lending rate. Thus (i) a uniform marginal lending rate undermines market discipline and (ii) structural bank characteristics could be used to adequately adjust the pricing of the MLF to bank specific structural liquidity risks. A bank specific MLF rate may thus be a complementary measure to the Basel III liquidity regulation.

Keywords: Lender-of-the-last-Resort lending, Structural bank characteristics, Predicting distress for single banks, Monetary policy implementation

JEL Classification: E58, G01, G21

1 Introduction

With the marginal lending facility (MLF), the Eurosystem provides Euro area banks unlimited anytime access to overnight liquidity at a fixed and known penalty rate against a broad range of collateral. By design, the MLF is thus close to the Bagehotian description of a Lender of Last Resort (LLR) facility: The Bagehot rule states that the central bank in its position as a LLR should lend freely against good collateral, but only at a penalty rate and only to illiquid but solvent institutions (Bagehot, 1873). In the presence of imperfectly functioning money markets, the discount window of the LLR is therefore supposed to help banks overcoming temporary liquidity shortages (see Bhattacharya and Gale, 1987). The presence of such a LLR facility should mitigate the pressure of banks to sell assets at fire sale prices, prevent inefficient liquidations of solvent banks, avoid contagion in interbank markets and negative externalities for the real sector.

The intention of a penalty rate on the LLR facility is to ensure that this facility is indeed only used as a last resort and to contain moral hazard. In Europe, the Eurosystem implements a homogenous penalty rate on the MLF which is usually set 100 basis points above the main refinancing rate. The idea of a homogenous penalty rate is to treat all financial institutions equal and to maintain a level playing field across banks (ECB, 2011). However, in practice, banks follow different business models and thus have varying degrees of liquidity risks. A homogenous penalty rate might then benefit particularly those banks that structurally run large liquidity risks or manage their liquidity imprudently. Furthermore, depending on their business model, the incentives for (liquidity) risk taking might vary across banks. In particular, the LLR option may give banks an incentive to underinvest in liquidity, ultimately turning to the LLR facility if they are hit by a liquidity shock (see Repullo, 2005). Consequently, a homogenous penalty rate on the MLF might actually distort competition, subsidize banks with higher liquidity risks, and crowd out banks with low liquidity risks. To avoid these problems, bank specific penalty rates related to banks' structural liquidity risk might be required.

The goal of this paper is to analyze whether banks differ in their structural propensity to take recourse to the MLF, the Eurosystem's LLR facility. In particular, we study whether a bank's likelihood to borrow from the LLR can be explained by *structurally* higher liquidity risks. The identification strategy is based on bank-specific (pre-crisis) *structural characteristics* which are used as instruments for explaining a bank's MLF access during subsequent crisis and non-crisis times. We define the structural characteristics as simple averages of bank-specific observables calculated *before* the onset of the financial crisis in August 2007. The idea is that these constructed means are not endogenous to contemporaneous funding problems a bank might face when taking recourse to the MLF but rather give an unbiased measure of time invariant bank characteristics, capturing its structural liquidity risks. Similar to Fahlenbrach, Prilmeier, and Stulz (2012), we thus hypothesize that the liquidity risk which results from a bank's chosen business model is rather a time invariant factor: banks with larger structural vulnerabilities to liquidity shocks in periods of relative normalcy should thus be particularly

likely to suffer when liquidity risks materialize.

For our empirical analysis, we match six unique and propriety micro data sets from the Deutsche Bundesbank, covering all banks registered in Germany. We use data on the MLF recourses, reporting the date and the amount a bank borrowed from this LLR facility. We match this data at the bank level with the monthly bank balance sheet statistics, the daily reserve fulfillments, the weekly bids submitted in the main refinancing operations (MROs), and the annual bank profit and loss statistics. Based on these bank-level information, we construct bank-specific time varying and time invariant (structural) measures for banks' liquidity risks and business model characteristics. The time span of our data covers three different crisis regimes, namely the subprime crisis, the Lehman collapse and the onset of the European sovereign debt crisis. This allows us to test the explanatory power of our variables over three different crises. Additionally, we test the structural means also in non-crisis times.

The key findings are that banks' liquidity risk management and business model attributes in the pre-2007 crisis time are highly predictive for their liquidity demand from the LLR during the subprime, the Lehman and the sovereign debt crisis. Moreover, we can show that the liquidity variables have an ex-ante explanatory power also for non-crisis times. Even when adding contemporaneous control variables and time fixed effects, the mean variables themselves remain highly significant. More precisely, banks with a structurally lower reserve fulfillment and a higher idiosyncratic funding liquidity risk in a time of normalcy have a significantly larger likelihood to revert the MLF and to draw significantly larger Euro amounts from the MLF. Hence, we find that exactly those banks that carry a structurally higher liquidity risk were the ones with a higher likelihood to take recourse to the LLR facility across various time periods. For those banks this implies that (i) the option to receive liquidity from the LLR at a fixed penalty rate has a higher value and (ii) the costless provision of such an option provides a greater subsidy to those banks.

Our findings imply that it might be inefficient to charge all banks in the banking system the same penalty rate. Since banks seem to have heterogeneous option values for borrowing from the LLR facility, depending on their structural liquidity characteristics, a uniform marginal rate seems to benefit certain banks significantly more than others. This undermines market discipline and might crowd out banks with a lower structural liquidity risk. Hence, the central bank should use structural bank characteristics to adequately adjust the pricing of borrowing from its LLR facility, thus creating an appropriate penalty rate based on the specific liquidity risk profile of a bank and thus to re-establish a level playing field.

The remainder of the paper is organized as follows: The next section gives an overview of the related literature, followed by a description of the Eurosystem's operational framework, in particular the marginal lending facility. In section 4 and 5 we introduce our data set, outline the construction of our key variables and introduce the empirical methodology. Section 6 outlines the empirical findings and section 7 and 8 conclude and derive policy implications.

2 Related literature

There is a vast literature studying how banks' characteristics affect their demand for liquidity from the European Central Bank (ECB). Papers such as Craig and Fecht (2007), Bindseil, Nyborg and Strebulaew (2009), and Fecht, Nyborg and Rocholl (2011) and Cassola et al. (2013) study the extent to which banks' bidding behavior in the Eurosystem's main refinancing operations is determined by contemporaneous vulnerabilities to tensions in interbank markets. Although we use a similar set of variables in our paper, contrary to those studies, we make use of bank-specific attributes calculated as structural variables over a phase before the start of the financial crisis and subsequently use them as instruments to analyze whether these structural characteristics have a predictive power for the access of banks to the LLR facility of the Eurosystem. A further related work to ours is Drechsler et al. (2013) who are more focussed on persistent bank characteristic, in particular their asset quality, and its impact on banks' bidding in the Eurosystem's MROs during the financial crisis. Similar to our work, these authors use bank-specific characteristic from before the financial crisis as instruments for their subsequent analysis about banks' borrowing in the MROs after the onset of the financial crisis.

However, all of these papers study the demand in the Eurosystem's main refinancing operations which constitutes the primary market for central bank liquidity rather than the recourse to the MLF which is the actual lender of last resort facility in Europe. The rates in these open market operations are closely linked to the rates in the interbank market. Thus, liquidity allocated in the MROs is not provided at a serious penalty rate and is therefore rather a first resort than a last resort measure. On the other hand, Fecht and Weber (2013) and Abbassi, Fecht and Weber (2013) study the determinants of banks' borrowing from the MLF and Armantier, Ghysels, Sarkar and Shrader (2011) do the same for U.S. banks recourse to the FED's discount window. However, those papers do not consider structural or persistent factors but rather focus on contemporaneous exposures to interbank market failures.

Thus, our paper is the first to study the structural determinants of the actual demand for LLR liquidity in Europe. A related paper to ours can be found only for the U.S. banking system: Puddu and Waelchli (2012) find a positive ex-ante correlation between banks that access the Fed's Term Auction Facility (TAF) during the financial crisis and their pre-crisis liquidity risk (defined as the maturity mismatch in their balance sheet) and their investment in illiquid collateral. However, the TAF could not be accessed on a daily basis, was organized as an auction, and was just introduced after the start of the crisis in 2007. In a similar vein, Acharya et al. (2014) analyze bank's likelihood of LLR borrowing from the Term Securities Lending Facility and the Primary Dealer Credit Facility and find that dealers with a lower degree of liquid collateral before the introduction of these facilities tended to borrow more during the crisis. However, the focus of the authors – similar to Drechsler et al. (2013) – is rather on solvency than on liquidity issues and the TSLF was, as the TAF, organized as an auction which should have preserved market discipline.

Our empirical analysis also makes an important contribution to the theoretical discussion on

the optimal design of the liquidity provision by the LLR. Diamond and Dybvig (1983) show that banks' liquidity transformation is welfare enhancing but makes them vulnerable to self-fulfilling runs, triggering liquidity shortages and the possible liquidation of solvent banks. However, as Skeie (2008) points out, given frictionless interbank markets, solvent but illiquid banks are always able to cover their liquidity needs in an efficiently working interbank market. Following that view, there would be no need for a LLR to overcome individual liquidity shortages except in the event of an aggregate liquidity shortage. Additional liquidity provision through open market operations would then be sufficient because the interbank market will ensure that the additional liquidity is allocated to those (solvent) banks in dearest need of liquidity (see e.g. Goodfriend and King, 1988). Thus given a frictionless interbank market, a LLR facility such as the MLF of the Eurosystem is redundant for overcoming liquidity shortages.

However, if the interbank markets do not work frictionless, then the liquidity provision of a LLR might be needed to prevent the liquidation of solvent banks. Indeed, various frictions can emerge in the money markets: Acharya, Gromb, and Yorulmazer (2012) for example argue that if individual banks gain market power in interbank markets, then these banks might squeeze other banks which induces an inefficient liquidation and takeover of solvent but illiquid banks. Freixas, Parigi, and Rochet (2000) on the other hand argue that coordination failures in the rollover of interbank deposits can lead to a liquidation of solvent banks. In addition, Rochet and Vives (2004) show that if market participants have different opinions about the solvency of a bank, then this bank may also become rationed from the interbank market. Furthermore, Freixas and Jorge (2008) show that in the presence of asymmetric information in the interbank market, solvent but illiquid banks might be rationed from the interbank system. If the LLR is in a better position to assess banks' solvency, his liquidity provision might be welfare enhancing (see Rochet and Vives (2004); Diamond and Rajan (2005)).

However, there are at least two costs of such a LLR liquidity insurance: First, if also the LLR is only imperfectly informed about banks' solvency, he might run into the risk of accidentally supporting insolvent banks which could give banks an incentive to enter excessive solvency risks as pointed out by Goodhart (1999). Secondly, if the central bank implements a LLR facility, banks may have an incentive to invest too much in illiquid leverage as argued by Acharya and Tuckman (2013), increasing the risk that a bank may suffer from a future funding liquidity shortfall as the LLR facility gives no incentive to a bank to reduce its degree of illiquid leverage in the short-term. Partially, these moral hazard problems can be mitigated through capital and liquidity regulations (see Fahri and Tirole, 2012). However, a penalty rate charged for LLR borrowing might be required to complement these measures in containing excessive risk taking incentives as argued by Freixas, Parigi, and Rochet (2004). In sum, according to this literature, the moral hazard problems and thus the optimal penalty rate are likely to vary across banks. Moreover, it is easy to see that a homogenous penalty rate provides an implicit subsidy to those banks with stronger liquidity risk taking incentives and a higher propensity to draw on the LLR facility. Obviously this distorts competition and crowds out banks with low risk taking

incentives and low vulnerabilities to liquidity shocks.

3 Institutional description

In the Euro area, banks are subjected to reserve requirements. Each bank has to hold an average end-of-day liquidity balance on its current account at its respective central bank in the Eurosystem over a reserve maintenance period (RMP). Not complying with the reserve requirement is very costly for a bank and the rate charged on an under-fulfillment is the highest interest rate that is set by the Eurosystem, although the Eurosystem has some discretion on how to penalize reserve under-fulfillments.

To allow banks to smoothly fulfill their reserve requirements, the Eurosystem supplies central bank reserves via open market operations (OMOs), in particular through its weekly main refinancing operations (MROs). In addition, it caters the liquidity demand of banks by conducting longer-term refinancing operations and fine-tuning operations. Usually, however, the bulk of liquidity is supplied through the weekly main refinancing auctions. Before the collapse of Lehman Brothers, these auctions were conducted as variable rate tender auctions, where banks bid for reversed repurchase agreements (repos) with a maturity of one week. Banks could submit up to 10 bid-quantity schedules with a minimum tick size of 1 basis point and a quantity multiple of 100,000 euros, where bids must at least equal the minimum bid rate set by the Eurosystem. If a bank's bid was successful, it is obliged to pay the rate it submitted to the Eurosystem and must supply eligible collateral.

Between two consecutive open market operations, banks may revert to the secured or unsecured money markets to cover their liquidity needs. Since lending in this market usually occurs by private banks with a liquidity surplus, these banks charge a premium for the credit risk of the borrowing bank. In crisis times, some banks may not be able to borrow even in the secured money market because of increased adverse selection risks, collateral constraints, and/or increased haircuts.

If banks fail to obtain adequate liquidity from the money markets, the Eurosystem offers an alternative source for overnight liquidity with the implementation of the marginal lending facility (MLF). This facility is similar to the U.S. Fed's discount window. Contrary to the U.S. Fed's counterpart, borrowing from the MLF has no stigma attached since the identity of banks borrowing from the European discount window (the MLF) cannot be inferred by market participants. The MLF offers banks anytime access to overnight liquidity without a restriction on the drawn amount, provided that banks can submit sufficient collateral. The marginal lending rate is significantly above the main refinancing rate, and hence, borrowing from this lender-of-the-last-resort facility is very costly to the bank. For the main part of our sample, this penalty rate was set 100 basis points above the MRO rate (see next section for details). Still, the marginal lending rate is below the rate charged if a bank would not comply with its reserve fulfillments. In order to treat all banks across the Euro area equal, and thus to establish a level playing field, the Eurosystem set the marginal lending rate at a pre-specified level and

at a uniform rate for all Euro area banks (see ECB, 2011).

4 Data and variables

We have compiled six unique micro data sets supplied by the Deutsche Bundesbank for the time period from 26. January 2004 to 11. October 2010 for all banks registered in Germany. The first data set covers the daily minimum reserve requirements and cumulative reserve holdings for each bank. The second and third data set list each institution's daily recourse to the marginal lending facility and the marginal deposit facility respectively. The fourth and fifth data set cover monthly bank balance sheet statistics and profit and loss statistics on a yearly basis. Finally, the sixth data set lists the bids submitted by banks in the weekly main refinancing operations which ends in October 2008 due to the ECB's introduction of fixed-rate tenders.

4.1 Data

From our raw data set, we drop *home savings and loan associations* and *special purpose banks* as well as banks with a zero reserve target, indirect reserve fulfillers, banks exempted from the reserve fulfillment for some reserve maintenance periods, and for which we cannot match the MLF recourses because there are no reserve data or where we had no bank balance sheet data available. The final data set is composed of 1,999 banks and 3,177,293 reserve and balance sheet observations as well as 4,671 recourse observations. At the beginning of our sample period, 1,942 banks were subjected to fulfill minimum reserves, whereas at the end of the sample, only 1,703 banks remained. Over the sample period a maximum number of 1,999 banks existed. Of the 1,999 banks, 82% or 1,642 banks operated over the whole sample period (1,751 reserve observations on average per bank). Finally note that if a bank was taken over by another bank, the two banks' time series are integrated at the merger date.¹

Since not all banks took part in the weekly main refinancing operations, we can match bids to only 35% of the banks in our sample (to 660 banks in total).² The remaining 1,372 banks did not participate in at least one MRO over the sample period.

4.2 Crisis and non-crisis periods

We define six mutually exclusive time periods for our empirical regressions. These six time regimes are depicted in Figure 1 which plots the three months Euribor to Eurepo spread, a key indicator for the persisting vulnerabilities in the European banking sector. The following equation summarizes the time intervals. The idea behind splitting our sample in time periods is that in each interval, banks with different business models and liquidity risk taking should

¹Note that when we match the profit and loss statistics, a further 253 banks drop out. We run all empirical models excluding profit and loss measures in the first place and the results stay qualitatively the same when including profit and loss measures. We prefer to report the results with profit and loss measures. The results from the other regressions are available upon request.

²Note that when we match the profit and loss statistics, 132 banks drop out.

have been affected differently and hence we can check with this approach whether structural bank characteristics are a consistent predictor over rather different time regimes. Note that all of our structural bank-specific means are calculated using the 'Normal phase (non-crisis)' time period $Period_i = 0$:

$$Period_i = \begin{cases} 0 - \text{Normal phase (non-crisis)} & \text{if Date} \geq 26 \text{ Jan } 2004 \ \& \ \text{Date} < 09 \text{ Aug } 2007 \\ 1 - \text{Start of the subprime crisis} & \text{if Date} \geq 09 \text{ Aug } 2007 \ \& \ \text{Date} < 12 \text{ Sep } 2008 \\ 2 - \text{Lehman collapse} & \text{if Date} \geq 12 \text{ Sep } 2008 \ \& \ \text{Date} < 21 \text{ Jan } 2009 \\ 3 - \text{Post Lehman \& normalization} & \text{if Date} \geq 21 \text{ Jan } 2009 \ \& \ \text{Date} < 6 \text{ Nov } 2009 \\ 4 - \text{Onset of the EU debt crisis} & \text{if Date} \geq 6 \text{ Nov } 2009 \ \& \ \text{Date} < 7 \text{ Sep } 2010 \\ 5 - \text{Greece bailout \& normalization} & \text{if Date} \geq 7 \text{ Sep } 2010 \end{cases} \quad (1)$$

The *subprime crisis* which had its roots in the housing market collapse in the U.S. may have particularly affected large banks with an exposure to the U.S. market and had only a comparatively lesser effect on the European wholesale market. The *collapse of Lehman Brothers* in September 2008 on the other hand brought a systemic crisis also to the European interbank market and the interval corresponds to the time span where the Eurosystem narrowed the interest rate corridor to 100 basis points. In the *post-Lehman* phase, a period of normalization started, where the Eurosystem widened the distance between the marginal lending rate and the key monetary policy rate again to 100 basis points and where the unsecured to secured money market spreads started to tighten again (see Figure 1). However, another turmoil started in November 2009 with the onset of the *European sovereign debt crisis* where fears about Greece sovereign debt mounted. The last two months of our sample correspond the the time period where Greece was bailed out and another – with hindsight short – period of normalization started again.

4.3 Variable set up

Since we want to estimate a probit model to analyze the propensity that a bank takes a recourse to the MLF, we construct our dependant variable as a binary indicator, $MLF-Recourse_{tj}$, which is equal to 1 if a recourse of bank j on date t is observed and zero otherwise. Concerning the explanatory variables, we construct six distinct sets which are described in more detail below. For the empirical regressions, we only use the means calculated of these variables for a period of normalcy (non-crisis periods) which gives us the structural factors we are interested in.

First, we extract two variables from the minimum reserve data: For a bank j at time t in the reserve maintenance period i (RMP), the reserve fulfillment ratio is given by

$$FulfillmentRatio_{tji} = \left(\frac{\sum_0^t MRA_{tji}}{\sum_0^t MRT_{tji}} \right) - 1 \quad (2)$$

where MRA is the current account of the bank at the central bank and MRT the daily reserve target. A value of zero for the *Fulfillment* ratio indicates that the bank has exactly fulfilled its required average daily reserve target at date t . A value below zero indicates that the bank is short in its reserve fulfillment, whereas a value above zero indicates that it is long in its reserve fulfillments.³ As a second variable from the minimum reserve data set, we calculate the rolling one-week standard deviation of the standardized actual account to measure the idiosyncratic funding liquidity risk of bank j ,

$$\text{Funding liquidity risk} = \left(\frac{MRA_{tj}}{MRT_{tj}} \right) \quad (3)$$

Secondly, we create a variable measuring the amount a bank has deposited at the marginal deposit facility (MDF). This indicates the degree of excess liquidity reserves the bank is holding.

$$\text{Liquidity Hoarding} = \left(\frac{MDF_{tj}}{MRT_{tj}} \right) \quad (4)$$

Thirdly, we construct three bank balance sheet ratios, where we define the variable $Size_{tj}$ as a measure for the size of the bank, the variable $Equity\ Ratio$ as the ratio of a bank's equity to its balance sheet sum, and $Interbank\ Obligations$ as the ratio of a bank's interbank lending to its balance sheet sum.

Forth, we calculate four indicators from the profit and loss statistics which are all normalized by the balance sheet sum (total assets): We define $NetInterestIncome$ as the income from a bank's maturity transformation, $NetProvisionIncome$ as the income proportion from banking-related services, and $NetTradingIncome$ as a measure for a bank's proprietary trading activities. Together, these three income shares form the operating income of a bank. As a fourth measure, we construct the variable $Loss\ Provisions$ measuring the allowance for receivables and securities as well as loan loss provisions to gauge the degree of riskiness of a bank's credit portfolio. Additionally, we define the $Cost-to-Income\ Ratio$ as a measure of bank's cost efficiency

$$\text{Cost-to-Income Ratio} = \left(\frac{\text{General Administrative Expenses}}{\text{Operating Income}} \right) \quad (5)$$

Next, we create an indicator measuring the willingness of a bank to pay for liquidity in the weekly open market operations. As in Abbassi, Fecht, and Weber (2013), we calculate a bank's willingness-to-pay from its submitted demand schedule (m bids) to the Eurosystem's weekly main refinancing auctions as the quantity-weighted interest rate

$$\text{QWRP}_{jt} = \left(\frac{\sum_{k=1}^m (\text{bid}_{ktj} \cdot \text{bid volume}_{ktj})}{\text{total bid volume}_{tj}} \right) \quad (6)$$

³When running regressions where we control for the contemporaneous values of a bank's reserve fulfillment, we prefer the economically more meaningful *net excess reserves* measure as defined in Fecht and Weber (2013). Let $T - t$ be the remaining number of days in the RMP i , then NEX is given by

$$NEX_{tji} = MRA_{t-1,ji} - MLF_{t-1,ji} - \left(\sum_0^T MRT_{tji} - \sum_0^{t-1} MRA_{tji} \right) / (T - t + 1),$$

and compute the measure $DIST_{tj}$ as the MLF rate minus the willingness-to-pay (QWRP). The wider $DIST$ is, the more aggressive a bank bid for central bank liquidity and hence the more constraint a bank is in terms of alternative refinancing opportunities.

In order to take *contemporaneous* (aggregate) market factors which prevailed on the day of an MLF recourse into account when estimating a bank's MLF propensity, we construct several time series variables: We define the variable *Counterparty Credit Risk* (CCR) as the difference between the *EONIA* rate (unsecured money market rate) to the *EurepoT/N* rate (secured money market rate), the *Eurepo Volatility* as the five day rolling standard deviation of the overnight repo rate, and the variable *MLF-Eurepo* as the distance of the MLF rate to the Eurepo rate. Additionally, we create a measure for the aggregate liquidity position of the banking system, by defining a *Liquidity imbalance* indicator similar to Fecht, Nyborg and Rocholl (2011) which measures the cross-sectional dispersion of the contemporary liquidity status (i.e. reserve holdings) at time $t - 1$ across the banking sector. As a forth money market variable, we define the *REX* to be the volatility of the key German fixed income index, "Deutscher Rentenindex". Fifth, the ECB liquidity policy indicator measures the changed liquidity allotment policy (e.g. front loading of liquidity) of the central bank over time,

$$ECB-LIQ_t = \frac{\text{Market Operations}_{t-1} - \text{Autonomous Factors}_{t-1} - \text{Reserve Requirements}_{t-1}}{\text{Reserve Requirements}_{t-1}} - 1.$$

Finally, we create a time dummy for the last day of the reserve maintenance period to account for the fact that any under-fulfillment should be reversed at the end of the maintenance period.

4.4 Mean variable construction

The key explanatory factors of interest in this paper are the mean variables which are constructed from the variables introduced above. These variables are the ones which will be used for the main empirical regressions. For each bank j , we calculate the following structural and time-invariant means over the *non-crisis* period, $Period_i = 0$, to use these as instruments for our regressions when analyzing borrowing from the LLR in different sub-sample periods.

$$\text{Mean Fulfillment Ratio}_0 = \left(\frac{\sum_0^t \text{Fulfillment}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean Funding Liquidity Risk}_0 = \left(\frac{\sum_0^t \text{LIQRisk}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean Liquidity Hoarding}_0 = \left(\frac{\sum_0^t \text{LIQHoarding}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean Equity Ratio}_0 = \left(\frac{\sum_0^t \text{EquityRatio}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean Size}_0 = \left(\frac{\sum_0^t \text{Size}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean Interbank Obligations}_0 = \left(\frac{\sum_0^t \text{InterbankObligations}_{tj}}{\sum_0^t t} \right) \forall t \in Period_i = 0$$

$$\text{Mean NetInterestIncome}_0 = \left(\sum_0^t \text{NetInterestIncome}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

$$\text{Mean NetProvisionIncome}_0 = \left(\sum_0^t \text{NetProvisionIncome}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

$$\text{Mean NetTradingIncome}_0 = \left(\sum_0^t \text{NetTradingIncome}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

$$\text{Mean Loss Provisions}_0 = \left(\sum_0^t \text{LossProvisions}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

$$\text{Mean Cost-to-Income Ratio}_0 = \left(\sum_0^t \text{Cost-to-IncomeRatio}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

$$\text{Mean DIST}_0 = \left(\sum_0^t \text{DIST}_{tj} / \sum_0^t t \right) \forall t \in \text{Period}_i = 0$$

4.5 Descriptive statistics

Table 1 shows whether banks that had accessed the MLF are different in terms of their structural mean characteristics from banks that never had an access to the MLF in a respective time period. In this table, we calculate our bank-specific *mean variables* for the period of normalcy only (i.e. January 2004 to August 2007), separated by (i) banks that had a recourse and those that never had a recourse (column 2), and (ii) separated further by the six distinct, non-overlapping, time periods (column 3 to 7) outlined in the variables construction section. The top of Table 1 also provides some background information about the number of MLF recourses and the number of banks which had a recourse to the MLF by time period. Note that an access to the MLF is a very rare event for an individual bank: the median number of MLF recourses per bank is 2 and the mode is 1 across the whole sample period.

Starting with the *Mean fulfillment ratio*, we see a clear tendency that banks which accessed the MLF had a significantly⁴ lower reserve fulfillment in the normal time (January 2004 to August 2007) than banks which did not revert to the MLF: Looking across the different time periods we see that banks which haven't had a recourse in a respective time period had a *mean fulfillment ratio* in the 'normal (non-crisis)' time period that was on average greater than 0.7 across all six time regimes, whereas banks with an MLF recourse had on average a ratio below 0.2 (which even declined over the time periods to around zero). Thus, a lower average reserve fulfillment ratio in the normal time period seems to be an indication that a bank is more likely to turn to the LLR facility in any of the crisis *and* non-crisis intervals.

Regarding the *Mean idiosyncratic funding liquidity risk*, we again find a highly significant relationship across both, crisis and non-crisis periods, and between banks that reverted to the MLF in a certain time period and those banks that did not: a bank that took recourse to the MLF had a much higher *structural* level of funding liquidity risk across all time periods. Although, the averages between recourse and non-recourse banks converge a bit towards the end of our sample period, the averages are still significantly different from each other. Thus, a bank

⁴Using a standard t-test with unequal variances, we find that the means are significantly different between banks with a MLF recourse and banks with no recourse.

with a structurally more "volatile" liquidity management in the normal time period should be more likely to revert to the MLF.

Looking at the *Mean liquidity hoarding* measure, defined as the nominal amount a bank deposited at the Eurosystem's marginal deposit facility divided by its reserve target, we find that banks with structurally higher excess liquidity holdings before August 2007 seem to be more likely to demand LLR liquidity during the subprime and also shortly after the Lehman crisis. However, with the onset of the European sovereign debt crisis, this behavior changed drastically, where banks with an MLF recourse had a lower *Mean liquidity hoarding* (1%) in the normal time period when compared to banks with no MLF recourses (5%).

With regards to the *Mean size* of a bank, we find that larger banks are significantly more likely to demand LLR liquidity. Both, pre-crisis and in-crisis size values peak around the Lehman crisis and decline thereafter but still, a bank without a recourse is on average significantly smaller in size than a bank that took a recourse.

The *Mean equity ratio* is the only variable, where – at least from the start of the Lehman collapse to the end of our sample – banks with an MLF recourse and banks with no recourse are not significantly different from each other.

Concerning the level of *Mean interbank obligations* – i.e. the lending exposure of a bank to the interbank market, relative to its balance sheet size – we find that banks which had in the normal time a higher degree of lending to the interbank market are more likely to revert to the MLF across all time periods. Whereas banks with a recourse had on average values above 23%, banks with no recourse had across all time periods a value of 17%.

For the *Mean DIST* variable, i.e. the difference between the MLF rate and a bank's willingness-to-pay in the weekly main refinancing auctions of the Eurosystem, we only find a marginally lower value for banks which took a recourse (and hence bid more aggressively in the MRO). Hence, recourse and no recourse banks seem to be not different from each other.

Turning to the profit and loss measures, it is evident that banks which didn't revert to the MLF had a significantly higher average *Mean net interest income* in the respective time period and that banks with MLF recourses generated a significantly higher proportion of their income from (i) *Mean provisions* and (ii) *Mean trading activities* until the onset of the Lehman crisis. After the onset of the Lehman crisis, the net income proportion from provision and trading activities which banks generated in the normal time period fell to about the same level as for the no recourse banks. In terms of the *Mean Cost-Income-Ratio*, we find that banks with a recourse had on average a lower CIR but also here, towards the end of our sample, the level of the CIR between the two groups seems to converge. In terms of the *Mean Loss Provisions*, at least for the period before August 2007, recourse and no recourse banks are about the same.

5 Methodology

5.1 Econometric strategy

To model the probability of a bank seeking LLR assistance, we apply a simple cross-sectional probit model, containing only the time-invariant exogenous variables.⁵ When including contemporaneous factors in the regressions, a panel probit model with the underlying latent variable model y_{it}^* that represents bank j 's propensity (or 'utility') to draw on the MLF is estimated as follows

$$y_{jt}^* = \alpha_j + \mathbf{x}'_{jt}\beta + e_{jt}, \quad y_{jt} = 1[y_{jt}^* > 0]$$

where y_{it} is equal to one if the respective bank has used the MLF ($y_{jt}^* > 0$) on date t and α_j is specified as a random effect. For our second empirical goal, the analysis of factors determining the banks' size of the MLF recourse, we need to account for the fact that we do not observe the recourse amounts of some banks since they had no recourse to the MLF. This problem calls for the Heckman correction (see Heckman, 1978 and 1979), where we first estimate a probit selection equation for the probability of a bank actually having a recourse. In the second stage, the outcome equation for the Euro size of the MLF recourse is estimated by including the inverse Mills ratio calculated from the first stage probit model as an additional explanatory variable

$$E(MLF_{jt}^{Amount} | y_{jt} = 1, x_{jt}) = \alpha_j + x'_{jt}\beta + \beta_\lambda \lambda_{jt} + \varepsilon_{jt}$$

where MLF_{jt}^{Amount} is the dependent variable measuring the Euro amount of the MLF recourse and β_λ is the inverse Mill's ratio. Note that u_{jt} and ε_{jt} are assumed to follow a bivariate normal distribution.

5.2 Model specifications

We use two samples when estimating a model: Sample (a) includes all 1,746 banks (i.e. all banks in the sample), whereas Sample (b) only accounts for those banks which took at least once part in a weekly main refinancing operation (538 banks in total). The reason why we run each model in two specifications is that the bidding behavior of banks in the weekly main refinancing operations already reflects the information content inherent in some of our liquidity measures which we hence decided to exclude in the regressions for banks with MRO bids.

Secondly, for both samples, we run six sub-regressions respectively for each model to test the explanatory power of our structural mean variables for the (i) whole sample period (August 2007 to October 2010), the (ii) subprime crisis only (August 2007 to September 2008), the (iii) Lehman crisis only (September 2008 to January 2009), the (iv) post-Lehman crisis only (January

⁵The dependent variable will equal 1 if bank j had at least one recourse in a respective time period. Thus, for the simple cross-sectional probit model, we regress each time invariant mean observation against this dependent binary observation. This constraint is relaxed when we include contemporaneous explanatory variables in our regressions, where we will then also use the contemporaneous MLF observation at time t .

2009 to November 2009), the (v) sovereign debt crisis only (November 2009 to September 2010), and the (vi) post-sovereign debt crisis only (September/October 2010). The idea behind this approach is to test the explanatory power of our structural means, calculated over the period of normalcy (January 2004 to August 2007), across different crisis and non-crisis times: The *subprime crisis* which had its roots in the housing market collapse in the U.S. may have particularly affected large banks with an exposure to the U.S. market and had only a comparatively lesser effect on the European wholesale market. The *collapse of Lehman Brothers* in September 2008 on the other hand brought a systemic crisis also to the European interbank market and the Eurosystem cut the distance between the marginal lending rate and the main refinancing rate to 50 basis points. In the *post-Lehman* phase, a period of normalization started, where the Eurosystem widened the distance between the marginal lending rate and the key monetary policy rate again to 100 basis points and where the unsecured to secured money market spreads started to tighten again (see Figure 1). However, another turmoil started in November 2009 with the onset of the *European sovereign debt crisis*. Here, particularly banks with a lending exposure to European crisis states should have been affected. Overall, in these time periods different banks should have been affected differently, depending on their respective business model, and hence we can check with this approach whether structural bank characteristics are a consistent predictor over rather different time regimes.

In Model 1(a), we account for the full set of the 1,746 banks in our sample. We introduce the *Mean Liquidity Risk (0)*, *Mean Fulfillment Ratio (0)*, and the *Mean Liquidity Hoarding (0)* as our structural variables measuring a bank's liquidity risk management. Note that 0 means that these variables have been calculated for the the normal phase from January 2004 - August 2007. The second set of variables, bank balance sheet measures, introduces the *Mean Size (0)* of the bank, the *Mean Equity Ratio (0)*, and the lending exposure of a bank to the money market, relative to its balance sheet size, *Mean Interbank Obligations (0)*. The third and final set of variables provides controls for a bank's business model: the *Mean Net Interest Income (0)* as the income share from a bank's maturity transformation, *Mean Net Provision Income (0)* as the income proportion from banking-related services, the *Mean Net Trading Income (0)* as a measure for a bank's proprietary trading activities, the *Mean Loss Provisions (0)* measuring the allowance for receivables and securities as well as loan loss provisions to gauge the degree of riskiness of a bank's credit portfolio and the *Mean Cost-to-Income Ratio (0)* as a measure of bank's cost efficiency.

Model 1(b) accounts only for those banks that participated at least once in a main refinancing operation (538 banks in total). We use the same set of variables as in Model 1(a) with the exception that we include the variable *Mean DIST (0)* as the measure for a bank's willingness-to-pay in the main refinancing operations. Since the bidding behavior might reveal information about the degree of reserve fulfillment and thus also about the excess reserve holdings, we exclude the measures *Mean Fulfillment Ratio (0)* and *Mean Liquidity Hoarding (0)* in Model

1(b).⁶

Note that both Model 1(a) and Model 1(b) are estimated by a pooled version of a probit model (see section 4.4) in order to estimate the effect of the structural predictors for *banks' propensities* to revert to the MLF. Hence, we only take the cross sectional variation into account.⁷ We relax this restriction in Model 3(a) and 3(b) when we include both structural as well as contemporaneous factors and apply a random effects panel probit model where we estimate the contemporaneous probability of a bank taking a recourse. As an additional control, we include a dummy variable specifying the banking group in all regressions.

In Model 2(a) and 2(b), we analyze whether structural characteristics not only affect the probability with which banks turn to the LLR facility but also whether the structural factors have an impact on the observed *nominal MLF amount* for all banks in the sample (Model 2(a)) and bidding banks only (Model 2(b)). For this purpose, we apply the two-step Heckman correction model. For the selection equation, we additionally use a banking group dummy variable (which we exclude for the outcome equation which estimates the nominal MLF amount drawn) and a contemporaneous variable equaling 1 for the last day of the reserve maintenance period (see section 4.3).

One could get the notion that the significance of our structural mean variables may be biased since they just serve as predictors for the contemporary (mean) values of those variables. We thus apply a panel probit specification in Model 3(a) (all banks) and Model 3(b) (bidding banks only) with a random effects specification to analyze whether our structural, time invariant, mean variables remain significant if we include their contemporaneous (i.e. day-by-day) values as an additional explanatory factor in the regressions. Note that we use the *Net excess reserve ratio* as the contemporaneous counterpart for the fulfillment ratio since this ratio is economically more meaningful of the real reserve fulfillment on a contemporary level than the fulfillment ratio.⁸ Moreover, since the structural *Mean Size (0)* and *Mean Liquidity Hoarding (0)* are highly correlated to their contemporary counterparts and thus increase the risk of multi-collinearity, we decided not to include their contemporary values.⁹ In addition, we include time fixed effects for each reserve maintenance period and control variables for the degree of money market frictions (*Counterparty credit risk*, *Eurepo volatility*, *Liquidity imbalances*) as well as the volatility of fixed income markets (*REX*), and a variable that measures the amount of liquidity the ECB allocated to the banking sector, relative to the amount of required minimum reserves. All these measures might have affected the recourse propensity of banks in the regressions. Note that all contemporary variables enter our regressions with a one day lag.

⁶As a robustness check, we also exclude the *Mean Liquidity Risk (0)* variable. Our results stay robust.

⁷We do not consider how often a bank took an MLF recourse in a respective time period. However, an access to the MLF is a very rare event for an individual bank: the median number of MLF recourses per bank is 2 and the mode is 1 across the whole sample period.

⁸Note that if we include the *Fulfillment ratio* instead of the *Net excess reserve ratio* on a contemporary basis, the result for the *Mean fulfillment (0)* ratio would remain consistently significant.

⁹Our results would not change if we were to include only the contemporary values of these variables and exclude the structural means.

Finally, one might argue that the *post-Lehman* and *post-Sovereign* sub-sample regressions should also rather be characterized as crisis times and don't constitute actual non-crisis times. Hence, we split in Model 4(a) (all banks) and Model 4(b) (bidding banks only) the normal time period in two sub-samples and calculate our structural mean variables for the time period from January 2004 to December 2005 and subsequently use them as structural predictor variables for banks' recourse to the MLF in the non-crisis time period January 2006 to July 2007 (and additionally, we also test this new specification for our structural mean variables in all other sub-sample time periods). Since we have not sufficient data points to construct meaningful structural means for the profit and loss measures, we exclude these variables in Model 4 completely.

6 Empirical Results

The results of our estimations are presented in Table 2 (Model 1(a)/(b)), Table 5 (Model 2(a)/(b)), Table 6 (Model 3(a)/(b)), and Table 7 (Model 4(a)/(b)). Each table is structured as follows: The first six columns present the estimation results when all 1,746 banks in the sample are accounted for (Models X(a)), whereas the last six columns present the estimation results for banks that bid at least once in a main refinancing auction (Models X(b)). Note that each of the six columns represents one distinct, non-overlapping, time period ordered as follows: the *All periods* column provides the estimation results for the sample period August 2007 to October 2010, the *Subprime* column the results for the period August 2007 to September 2008, the *Lehman* column the results for the period September 2008 to January 2009, the *Post-Lehman* column the results for the period January 2009 to November 2009, the *Sovereign* column the results for the period November 2009 to September 2010, and the *Post-Sovereign* column the results for the period September to October 2010.

Turning to the regression results of our pooled probit estimation in Table 2, we find that all key variables have the expected sign and that the Pseudo-R² is satisfactory for a probit model specification across all models, irrespective whether the all banks or only the bidding banks samples are used.

Starting with Model 1(a) and the the liquidity characteristics of banks, we find across *all* six time periods that banks which had a more volatile liquidity management (*Mean Liquidity Risk (0)*) and banks that had on average a lower average reserve fulfillment (*Mean Fulfillment Ratio (0)*) in the pre-August 2007 time, have a significantly higher propensity of drawing liquidity from the LLR facility. The *Mean Liquidity Hoarding (0)*, however, contains seemingly no structural information about the probability of banks to access the LLR facility. We thus conclude that banks that were subjected to larger idiosyncratic liquidity shocks and banks that fulfilled their reserves less prudently (by fulfilling their reserves rather towards the end of the maintenance period) in the pre-crisis time had a significantly higher option value in the subsequent time periods to revert to the LLR facility than banks with a more prudent liquidity management. This also implies that banks with high structural liquidity risks seem to benefit more from an homogenous marginal lending rate.

Looking at the balance sheet variables, we find that larger banks are more likely to borrow from the MLF. This result is very robust across all six time periods and holds despite controlling for the banking groups in all regressions, thus already accounting for the fact that many of the smaller banks are part of liquidity networks (savings banks and credit cooperatives) which should reduce their ex-ante structural likelihood to revert to the MLF (see Freixas, Parigi and Rochet, 2004). Hence, although larger banks are often supposed to be better protected against liquidity shocks due to their diversified business model, we find that they seemingly are structurally more susceptible to sudden liquidity shocks.¹⁰ Interestingly, neither the *Equity ratio* nor the *Interbank obligations* provide any consistent structural gauge on banks' MLF recourse propensity.

Turning to the profit and loss measures which provide a granular control for the business model of banks, we find that banks which generated a larger share of their income from the traditional maturity transformation business were significantly less likely to turn to the LLR facility across the various time regimes. Although there is a weaker relationship for trading activities, we can nonetheless say that banks which generated a larger share of their income from trading activities were overall more likely to turn to the LLR. This is not surprising, given that banks with more capital markets exposure were hit most by the turmoil in the asset markets. The *Cost-to-Income* (CIR) ratio on the other hand, predicts a strongly negative impact for MLF borrowing across all time periods (except for the last two months of our sample period): Banks which have a higher CIR, are less likely to turn to the MLF. Institutions with a high CIR are often those that have a significant amount of branches which usually goes hand-in-hand with a more conservative business model and this may also hint to a more conservative liquidity risk management culture. Neither *Loss provisions* nor *Net provision income* provide informational value about banks' structural prosperity to revert to the LLR.

In Model 1(b) we included only those banks that bid at least once in an MRO and introduce the variable *DIST* and exclude the variables *Mean Fulfillment Ratio (0)* and the *Mean Liquidity Hoarding (0)*. Looking at the banks' willingness-to-pay measure, *DIST*, we find for the subprime crisis phase that banks which bid more aggressively in the MRO auctions – hence having a higher willingness-to-pay – also have a higher likelihood of reverting to the LLR facility. However, for the time periods after the subprime crisis, the *DIST* measure seemingly carries no informational content for banks' structural prosperity to revert to the LLR facility.¹¹ Thus, the information content inherent in the *DIST* variable seemingly has only a short life-time and may serve only as a short-term structural measure for banks' likelihood to demand LLR liquidity. The finding that *Size (0)* is less important in the *bidding banks only* regressions has to do with the fact that rather the larger banks tend to take part in the weekly main refinancing operations (see Fecht, Nyborg and Rocholl (2011); Craig and Fecht (2007)). Except for the *Cost-Income-Ratio*, all other variables have broadly the same level of significance as in Model 1(a).

¹⁰Note that these results hold, if we introduce the restriction that the MLF amount drawn must exceed at least 10% of the bank's reserve target for a respective reserve maintenance period, and hence when we would disregard those MLF recourses in our regressions.

¹¹This result holds, even when we exclude the *Mean Liquidity Risk (0)*.

[Table 2 about here]

To ease the interpretation of the regression coefficients and to give an intuition of their economic significance, we calculate average marginal effects (AME) for all coefficients of Model 1(a) and Model 1(b).¹² Table 3 shows the AMEs for each explanatory variable for the *All periods* outcome of Model 1(a).¹³ For example, a one-unit increase in the *Mean Fulfillment Ratio* (increase of a bank's reserve fulfillments by 100% or 1 unit) decreases the probability of an MLF recourse of a randomly-picked bank on average by 26.4% percentage points. However, particularly the curves for the profit and loss measures are changing quickly which makes a tangential approach to the results interpretation less appropriate, and hence, a more intuitive way of interpreting the results is in terms of predicted probabilities.

[Table 3 and 4 about here]

Figure 2 presents the plots of six key variables for the *All Periods* outcome of Model 1(a), where we calculate predicted probabilities at representative values of these variables. The dotted lines depict a 95% confidence interval. As it can be seen, particularly a highly volatile liquidity management predicts a probability of 1 that banks will c.p. access the LLR facility. On the other hand, banks which have fulfilled their reserves already at the start of the reserve maintenance period or even over-fulfilled their reserves on average (*Mean Fulfillment Ratio* > 1), have c.p. a very low predicted likelihood to demand liquidity from the LLR facility.

[Figure 2 about here]

For the central bank it is interesting to not only know what structural factors lead to a higher propensity for banks to demand liquidity but also what factors influence the amount they will demand from the Eurosystem's LLR facility since this is ultimately the central bank's credit exposure. For this propose, we estimate in Model 2(a) and 2(b) a Heckman selection model for the *nominal MLF amount* drawn and present the results in Table 5. Looking at the outcome equation of Model 2(a) which depicts the results for the demand for the nominal MLF amounts for all banks in the sample, we see a strong tendency that banks with a structurally higher liquidity risk or lower reserve fulfillment are not only more likely to revert to the MLF (see results of Model 1(a)/1(b)), but also demand higher amounts of liquidity. A weaker relationship exists for the *Size* of banks, where we nonetheless see a tendency that larger-sized banks also draw a larger Euro amount from the LLR facility and that banks with a higher *Equity ratio* and more *Interbank lending* demand a lower absolute MLF amount. The latter three findings are

¹²We thereby first calculate the marginal effect for the probability of a bank taking recourse to the MLF with respect to an explanatory factor for each bank-case individually and then average these effects over all banks in our sample.

¹³Table 4 depicts descriptive statistics (mean, standard deviation, and inter-quantile range) for our key mean variables over the six distinct time regimes to ease the interpretation of the average marginal effects and predicted probability plots.

however not consistently significant across the six time period specifications. Apart from these factors, we do not find consistently important factors for explaining the drawn MLF amount. Turning to the results for *bidding banks only* regressions in Model 2(b), we do not find strong evidence that the willingness-to-pay measure serves as a good predictor for the drawn MLF amount. Apart from that, the significance of our coefficients in Model 2(b) are very similar to the results of Model 2(a).

[Table 5 about here]

So far we only accounted for the cross-sectional variation of our data. In Model 3(a) and 3(b) we relax this and account for the whole panel structure of our data set and estimate a random effects panel probit model to analyze whether the structural means remain significant when we add their contemporary values, hence checking whether the structural means really convey additional informational value above what is reflected in their contemporary values. Turning to the results of Model 3(a) in Table 6 which contains the estimations for the contemporary MLF access likelihood of a bank and includes maintenance period time fixed effects¹⁴ as well as various other control variables that might affect a bank’s recourse probability, we find that the signs and statistical significance of our results stay about the same, with the exception of the control variable *Mean Net Trading Income (0)* which has turned insignificant. Noteworthy is that the *Mean reserve fulfillment* and the *Mean funding liquidity risk* remain highly significant, despite including the *Net Excess Reserves Ratio* and the *Funding liquidity risk* on a contemporary basis. This implies that the structural liquidity management factors are very robust predictors also for a bank’s contemporary likelihood to turn to the LLR facility and hence, contain significant informational value above what is reflected in their contemporary counterparts.¹⁵ Note that the various contemporary control variables have the expected sign but we refrain from the interpretation of their results in this paper (see Fecht and Weber (2013) for a more details).

[Table 6 about here]

Up to now, our results show that in particular the structural liquidity measures contain a significant informational value for a bank’s (structural) LLR access during various time periods after August 2007. For policymakers – and as a further robustness check that our liquidity measures can be used as structural (pricing) indicators across crisis and non-crisis times – it would be interesting to see if the indicators perform well also in a very tranquil time period. We thus re-estimate Model 1(a) and 1(b) with a different specification for the structural means: this time, the means are calculated only over the time period January 2004 to December 2005. Subsequently, these means are used as instruments for banks’ recourse to the LLR facility in

¹⁴Reserve maintenance period time fixed effects are approximately equal to four-week time fixed effects.

¹⁵One might argue that only larger, more economically significant, recourses really indicate significant funding stress for a bank. We therefore re-run Model 3(a) and 3(b) with the restriction that only those MLF recourses which are larger than 10% of a bank’s daily reserve requirement are included in the regression. We do not find any major change of our results.

the non-crisis time period January 2006 to July 2007 (and as a robustness check also for the six sample time periods used for model 1 to 3). Turning to the results of Model 4(a) in the first column of Table 7 (*2006/2007*), it can be seen that the *Mean Fulfillment Ratio (2004/2005)* and the *Mean Liquidity Risk (2004/2005)* are highly significant structural predictors also for the tranquil time period 2006/2007, whereas most other explanatory factors only remain weakly significant (for example the *Size* of a bank). The *DIST (2004/2005)* measure in Model 4(b) on the other hand turns out to be insignificant also for the subprime crisis.

[Figure 7 about here]

Overall, we conclude that particularly the two key liquidity management variables, (*Mean Fulfillment Ratio* and *Mean Liquidity Risk*), seem to serve as good and consistent structural predictors for banks' likelihood to turn to the LLR as well as the nominal amount banks will demand from the LLR across various time regimes.

7 Conclusions

This paper sheds light on the question whether banks have significantly varying option values for the demand for overnight liquidity from the Eurosystem's LLR facility. For answering this important policy question, we constructed structural, bank-specific, characteristics extracted from a period of relative normalcy and used these means as instruments for explaining the likelihood and the drawn nominal MLF amount that banks will demand from the LLR facility under different crisis and non-crisis regimes.

We can show that banks with an ex-ante lower structural liquidity risk and banks that fulfill their reserves more prudently in a period of normalcy are significantly less likely to revert to the LLR facility in crisis and non-crisis times and that these banks will also demand a lower nominal MLF amount. Even when we calculate the structural liquidity management measures over a highly tranquil period and subsequently use them as instruments in another tranquil period, they still contain significant informational value about banks' recourse propensities. Hence, we conclude that banks with a more risky liquidity management profile seem to have a (structurally) higher option value to draw liquidity from the LLR facility. Our results are very robust, even when adding contemporary control variables, controlling for business model specifics of a bank, and including time-fixed effects. In sum, this also implies that the liquidity management indicators seem to provide a useful basis for charging a bank-specific, risk-adjusted, marginal lending rate.

Since we can show that a bank's structural liquidity management activity and business model specifics before the onset of the financial crisis in August 2007 are important determinants for its subsequent access to the Eurosystem's LLR facility during all three crisis times, we can thus confirm the reasoning of Fahlenbrach, Prilmeier, and Stulz (2012) for the U.S., namely that the risk management culture and the business model specifics of a bank seem to be rather time invariant factors. Moreover, our finding the bidding behavior of a bank seems to contain useful

information only for a very short-term prediction horizon implies that it is a less appropriate structural pricing indicator. Hence, although Abbassi, Fecht and Weber (2013) could demonstrate that the *DIST* measure can be used to predict a bank’s MLF recourse between two main refinancing operations, we find that this variable is not well suited as an effective structural indicator for measuring a bank’s LLR access likelihood and therefore is also a less appropriate indicator for charging a bank specific risk-adjusted marginal lending rate.

Finally, various theoretical contributions have highlighted that interbank markets don’t work frictionless and that the liquidity provision of a LLR may be desirable (see for example Achariya, Gromb, and Yorulmazer (2012); Freixas and Jorge (2008); Freixas, Parigi, and Rochet (2000)). Since Fecht and Weber (2013) empirically show that the Euro area interbank market is affected by various market imperfections, we also argue that there is a role for a LLR facility in the Euro area. However, as pointed out in the literature review section, there are costs related to moral hazard problems which might require a penalty rate charged for LLR borrowing (see Freixas, Parigi, and Rochet, 2004). However, the optimal penalty rate is likely to vary across banks if the incentive of banks to take liquidity risks varies. Since we show in this paper that the option value of banks to draw from the Eurosystem’s LLR facility indeed varies significantly across banks, particularly depending on the prudence of their liquidity management, we thus conclude that the homogenous penalty rate the Eurosystem currently charges on its LLR facility provides an implicit subsidy to banks with stronger (liquidity) risk taking incentives since these banks seem to have a higher value to draw on the LLR facility. Obviously this distorts competition and undermines market efficiency.

8 Policy Implications

Since banks value the LLR facility differently across crisis and non-crisis periods, depending on their specific liquidity management and business model characteristics, a homogenous marginal lending rate seems to undermine market efficiency since the presence of a LLR option feeds back to market conditions. In order to avoid this, a penalty rate pegged to the individual (liquidity) risk profile of a bank might be appropriate.

Charging a penalty rate that is adjusted to a bank’s structural recourse propensity might also be advisable for a central bank from a risk management perspective. For banks with a higher structural liquidity risk, the central bank is more likely to get a credit exposure (due to the higher propensity to revert to the LLR facility) and if so, will have a larger credit exposure (due to the larger nominal amounts demanded from the LLR facility). Thus, an adjusted penalty rate might reduce the MLF demand by these banks and compensate the central bank for the greater credit risk assumed when providing the option to obtain liquidity through its marginal lending facility.

As argued by various economists, in the presence of imperfect interbank markets, a marginal lending facility can increase the economic welfare. However, given our findings and to contain moral hazard problems, policymakers in the Eurosystem might think about charging banks a

risk-adjusted mark-up on the homogenous penalty rate to re-establish the level playing field across banks in the Euro area. The pricing should reflect the structural factors of the respective financial institution, particularly structural factors related to the fulfillment behavior of minimum reserves and banks' idiosyncratic funding liquidity risk. The U.S. Fed for example provides a *Secondary Credit* facility to institutions with a less sound financial profile at a mark-up on the penalty rate set on the discount window (primary credit facility similar to the MLF). Moreover, we can conclude that just by looking at the degree of reserve fulfillment and the volatility of the reserve management of banks, banking supervisors may identify banks which are likely to be rationed in the interbank market in times of crisis (and non-crisis) periods. Hence, our finds might also be interesting for microprudential supervision.

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Figure 1: Defining the money market regimes (3 months Euribor - 3 months Eurepo) in %

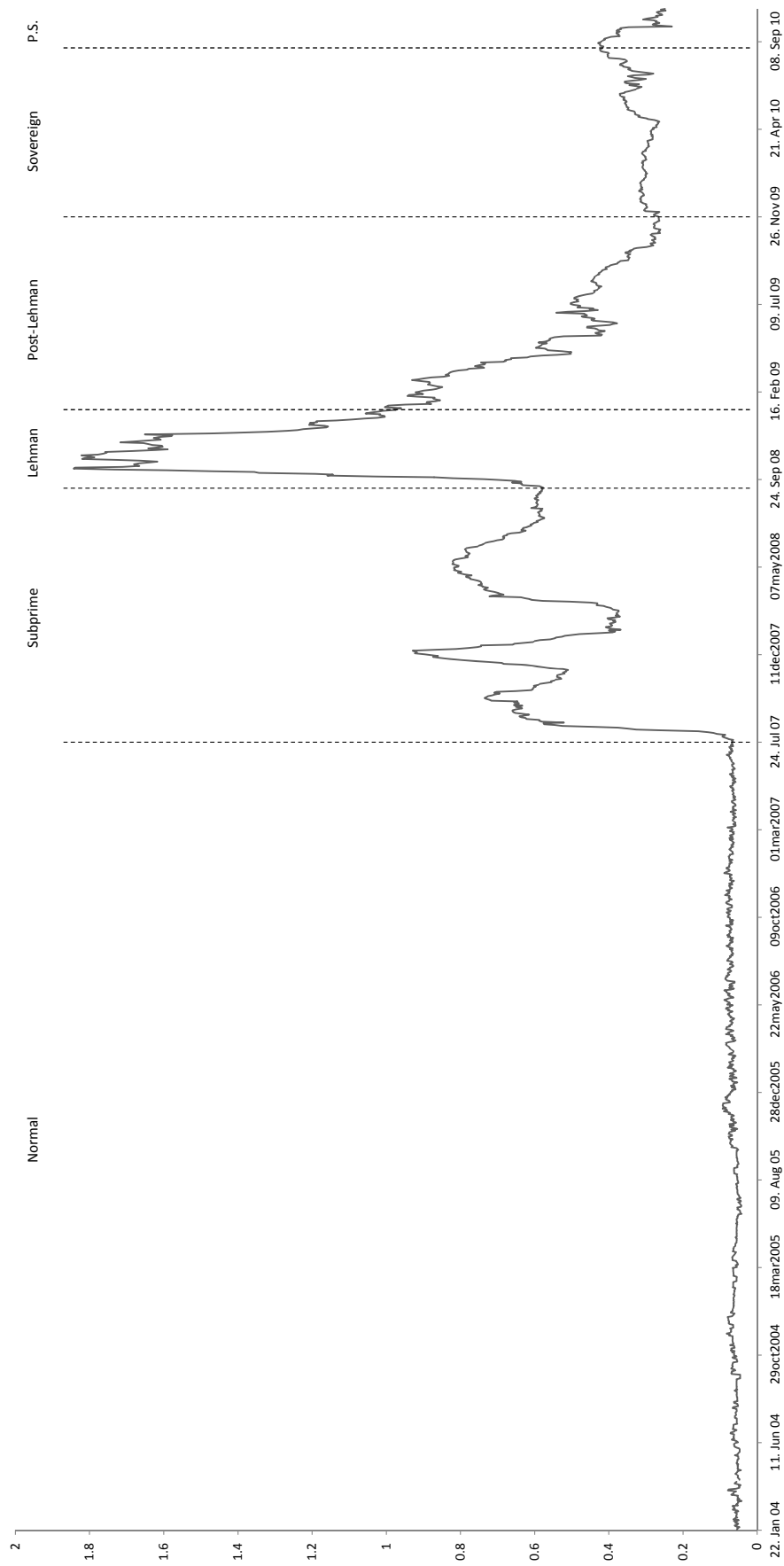


Table 1: Summary statistics for the main explanatory variables

This table presents the statistical means of our key explanatory variables for (i) banks which had **no-recourse** to the MLF and (ii) banks that had at least one **recourse** to the MLF over the respective time period. The variables are calculated as simple averages for each bank over the time period January 2004 to August 2007 only. For example, looking at the *Mean Fulfillment Ratio (0)* for the August 2007 to September 2008 time period, we find that banks with an MLF recourse had on average a reserve fulfillment of only 19% in the period of normalcy, whereas a non-recourse counterpart had a much higher average reserve fulfillment (83%) in the period of normalcy. We use the whole sample of banks except for the *DIST* measure which only takes into account banks which participated in at least one main refinancing operation. Note: * indicates that the respective profit and loss measures is calculated relative to the average total assets observed from the balance sheet statistic between January 2004 to August 2007.

Sample Descriptive Statistics		Normal (0)	Subprime (1)	Lehman (2)	Post-Lehman (3)	Sovereign (4)	Post-Sovereign(5)
Time Period		Jan04-Aug07	Aug07-Sep08	Sep08-Jan09	Jan09-Nov09	Nov09-Sep10	Sep10-Oct10
Total observations		1,730,244	511,126	162,804	359,538	371,093	42,548
Total number of MLF recourses		2,673	624	422	531	364	57
No. of banks		—	1,814	1,762	1,763	1,728	1,708
No. of banks with MLF recourse		—	169	136	176	130	41
Normal Time							
Mean Fulfillment Ratio (0)	no-recourse	0.56	0.83	0.77	0.74	0.76	0.77
	recourse to MLF	0.19	0.19	0.14	0.15	0.07	-0.01
Mean Liquidity Risk (0)	no-recourse	0.52	0.70	0.65	0.62	0.64	0.64
	recourse to MLF	1.06	0.99	0.74	0.78	0.68	0.49
Mean Liquidity Hoarding (0)	no-recourse	0.02	0.04	0.03	0.05	0.05	0.05
	recourse to MLF	0.79	0.75	0.06	0.45	0.01	0.01
Mean Size in Mio (0)	no-recourse	3.2	3.3	3.2	3.1	3.1	3.1
	recourse to MLF	16.0	16.5	25.1	23.1	22.3	22.0
Mean Equity Ratio (0)	no-recourse	0.06	0.06	0.06	0.06	0.06	0.06
	recourse to MLF	0.11	0.09	0.06	0.06	0.06	0.06
Mean Interbank Obligations (0)	no-recourse	0.17	0.17	0.17	0.17	0.17	0.17
	recourse to MLF	0.33	0.34	0.27	0.27	0.23	0.25
Mean DIST (0)	no-recourse	0.94	0.94	0.94	0.94	0.94	0.94
	recourse to MLF	0.94	0.94	0.94	0.94	0.94	0.93
Mean Net Interest Income (0)*	no-recourse	2.54%	2.53%	2.54%	2.54%	2.54%	2.54%
	recourse to MLF	1.70%	1.65%	1.54%	1.63%	1.80%	1.62%
Mean Net Provision Income (0)*	no-recourse	0.76%	0.77%	0.77%	0.77%	0.76%	0.76%
	recourse to MLF	1.85%	1.04%	0.80%	0.76%	0.85%	0.76%
Mean Net Trading Income (0)*	no-recourse	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
	recourse to MLF	0.05%	0.05%	0.01%	0.02%	0.03%	0.03%
Mean Cost-Income-Ratio (0)	no-recourse	74%	74%	74%	74%	74%	74%
	recourse to MLF	69%	56%	41%	52%	52%	71%
Mean Loss Provisions (0)*	no-recourse	0.56%	0.55%	0.55%	0.55%	0.55%	0.55%
	recourse to MLF	0.54%	0.45%	0.38%	0.42%	0.44%	0.66%

Table 2: Main Results I - Modeling the probability of a recourse to the MLF using structural factors only

This table presents the empirical results for model I(a) and I(b) using a pooled probit regression with robust standard errors, i.e. it presents the estimation results for the likelihood that a bank will use the Eurosystem's LJR facility. The dependent variable is equal to 1 for a single bank if at least one MLF recourse is observed in the respective time period. All independent **Mean ... (0)** variables are calculated as simple averages for the period of normalcy from January 2004 to August 2007. The bidding banks regression (Model I(b)) only considers those banks which participated at least once in a main refinancing operation before August 2007. The **All periods** regression accounts for the sample period August 2007 to October 2010, the **Subprime** regression for the time period August 2007 to September 2008, the **Lehman** regression for the time period September 2008 to January 2009, the **Post-Lehman** regression for the time period January 2009 to November 2009, the **Sovereign** regression for the time period November 2009 to September 2010, and the **Post-Sovereign** regressions for the time period September and October 2010. Due to space restrictions, the coefficients for the banking group dummy variables (BGR) are omitted from this table.

	Model I(a) (All banks in the sample)				Model I(b) (Bidding banks only)								
	All periods	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign	All periods	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign	
Liquidity Mean Variables													
Mean Liquidity Risk (0)	0.969*** (0.273)	1.048*** (0.327)	0.551*** (0.200)	0.641*** (0.214)	0.637** (0.296)	0.729** (0.303)	2.350*** (0.449)	2.730*** (0.505)	1.494*** (0.491)	1.294** (0.542)	1.646*** (0.503)	1.137** (0.541)	
Mean Fulfillment Ratio (0)	-1.112*** (0.305)	-1.279*** (0.377)	-0.613*** (0.219)	-0.922*** (0.302)	-0.999** (0.498)	-1.157*** (0.386)							
Mean Liquidity Hoarding (0)	0.152 (0.291)	0.495 (0.392)	-0.0185 (0.0219)	0.0599** (0.0295)	-0.717 (0.887)	-0.492 (0.755)							
Mean DIST (0)							-2.596 (1.985)	-3.673* (1.935)	-0.607 (2.372)	-0.411 (1.831)	2.867 (2.942)	-3.916 (3.671)	
Balance Sheet Mean Variables													
Mean Size in logs (0)	0.218*** (0.0359)	0.245*** (0.0487)	0.0854** (0.0427)	0.156*** (0.0420)	0.120** (0.0482)	0.0717 (0.0687)	0.130* (0.0703)	0.143* (0.0793)	0.00954 (0.0806)	0.142* (0.0860)	0.103 (0.0848)	-0.0293 (0.128)	
Mean Equity Ratio (0)	-0.534 (1.002)	1.038 (1.175)	1.601 (1.084)	0.236 (1.039)	1.740* (1.001)	0.769 (1.405)	-1.868 (2.383)	-1.464 (2.033)	0.386 (2.069)	2.015 (2.275)	0.608 (2.007)	-2.956 (2.073)	
Mean Interbank Obligations (0)	-0.507 (0.427)	-0.336 (0.440)	-0.0312 (0.445)	-0.907** (0.448)	-0.237 (0.530)	-0.375 (0.586)	0.206 (0.730)	-0.248 (0.779)	0.203 (0.796)	-0.999 (0.817)	-0.825 (0.795)	-1.153 (0.898)	
Profit/Loss Mean Variables													
Mean Net Interest Income (0)	-14.65*** (5.582)	-20.50*** (6.936)	-11.05* (5.958)	-12.54** (5.755)	-5.810 (6.348)	-24.31** (11.11)	-28.09** (14.11)	-34.90** (17.33)	-0.237 (16.19)	-6.144 (16.65)	-0.141 (15.41)	-23.17 (21.94)	
Mean Net Provision Income (0)	10.70 (8.019)	6.121 (9.550)	-2.558 (2.282)	-3.824 (2.364)	1.106 (6.524)	-0.848 (6.937)	40.29 (27.31)	34.62 (26.22)	13.83 (22.61)	-3.429 (22.80)	-3.353 (23.44)	49.87** (25.35)	
Mean Net Trading Income (0)	143.0** (67.88)	192.6*** (69.66)	-52.66 (87.33)	45.55 (70.57)	148.9* (79.53)	-49.45 (137.9)	112.1 (109.4)	181.8** (91.85)	-188.0 (163.0)	35.99 (99.94)	119.6 (118.1)	-201.0 (161.4)	
Mean Cost-Income-Ratio (0)	-0.0999 (0.0999)	-0.392*** (0.121)	-0.247*** (0.0870)	-0.189** (0.0963)	-0.265*** (0.0872)	0.119 (0.151)	-0.719 (0.588)	-0.624 (0.649)	-0.608 (0.669)	-0.517 (0.567)	0.237 (0.576)	-0.247 (0.885)	
Mean Loss Provisions (0)	-4.135 (5.767)	2.429 (6.267)	-4.973 (5.634)	-1.666 (5.879)	-5.416 (5.420)	8.646 (5.437)	-9.320 (7.769)	26.60 (37.97)	-15.33** (6.655)	-45.75 (42.55)	-25.70 (33.80)	8.991 (6.291)	
BGR	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	
Constant	-3.413*** (0.894)	-5.419*** (1.152)	-2.171* (1.109)	-2.212* (1.132)	-2.468* (1.284)	-2.298* (1.238)	0.137 (2.478)	-0.781 (2.525)	-0.395 (3.133)	-1.566 (2.540)	-5.306 (3.348)	3.374 (3.932)	
Summary Statistics													
Observations/Number of banks	1746	1746	1694	1691	1649	1627	538	538	520	524	510	503	
Deg. of freedom (model)	17	17	17	18	18	17	16	16	15	17	16	15	
Log likelihood	-743.7	-333.7	-382.6	-452.8	-353.1	-134.2	-256.1	-170.2	-156.2	-158.6	-136.8	-70.74	
Pseudo R2	0.164	0.342	0.132	0.141	0.169	0.240	0.230	0.317	0.243	0.223	0.243	0.309	

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table 3: Average Marginal Effects (AME) for Model 1(a) and Model 1(b)

This table presents the average marginal effects (AME) of each explanatory variable for Model 1(a) and Model 1(b). AMEs are extracted from the estimated probit model by first calculating the marginal effect for the probability of a bank having recourse to the MLF with respect to an explanatory factor for each bank-case individually. In a second step, these marginal effects are averaged across all banks in our sample. Intuitively, the AME is the mean of the distribution of marginal effects across all banks in our sample for a respective explanatory variable. The AME thereby refers to the average increase/decrease in the probability of a randomly-picked bank having recourse to the MLF if an explanatory factor is increased by one unit while holding the other explanatory factors fixed. Table 4 provides an overview of the means and the variation of each explanatory variables across the different time regimes.

	AME for Model 1(a) (All banks in the sample)					AME for Model 1(b) (Bidding banks only)						
	All periods	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign	All periods	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign
Liquidity Mean Variables												
Mean Liquidity Risk (0)	0.231*** (0.0634)	0.106*** (0.0325)	0.0662*** (0.0243)	0.0933*** (0.0309)	0.0736*** (0.0333)	0.0299** (0.0132)	0.629*** (0.112)	0.472*** (0.0825)	0.243*** (0.0793)	0.213** (0.0881)	0.239*** (0.0719)	0.0847** (0.0412)
Mean Fulfillment Ratio (0)	-0.264*** (0.0707)	-0.129*** (0.0372)	-0.0738*** (0.0265)	-0.134*** (0.0436)	-0.115*** (0.0559)	-0.0476*** (0.0177)						
Mean MDF (0)	0.0344 (0.0673)	0.0499 (0.0395)	-0.00204 (0.00265)	0.00894** (0.00428)	-0.0792 (0.0993)	-0.0197 (0.0310)						
Mean DIST (0)							-0.690 (0.530)	-0.640* (0.336)	-0.0965 (0.384)	-0.0649 (0.301)	0.415 (0.432)	-0.289 (0.270)
Balance Sheet Mean Variables												
Mean Size in logs (0)	0.682*** (0.112)	0.339*** (0.0702)	0.137** (0.0694)	0.296*** (0.0818)	0.175** (0.0750)	0.0452 (0.0386)	0.471* (0.265)	0.366* (0.199)	0.0136 (0.185)	0.323 (0.206)	0.222 (0.180)	-0.0377 (0.133)
Mean Equity Ratio (0)	-0.122 (0.237)	0.109 (0.119)	0.191 (0.129)	0.0323 (0.149)	0.195* (0.114)	0.0326 (0.0584)	-0.506 (0.633)	-0.250 (0.351)	0.0588 (0.335)	0.324 (0.372)	0.0898 (0.291)	-0.222 (0.156)
Mean Interbank Obligations (0)	-0.122 (0.101)	-0.0346 (0.0444)	-0.00453 (0.0532)	-0.131** (0.0644)	-0.0280 (0.0601)	-0.0157 (0.0241)	0.0538 (0.195)	-0.0404 (0.135)	0.0314 (0.129)	-0.165 (0.134)	-0.119 (0.115)	-0.0867 (0.0702)
Profit/Loss Mean Variables (all in %)												
Mean Net Interest Income (0)	-0.0351*** (0.0131)	-0.0209*** (0.00715)	-0.0133* (0.00707)	-0.0182** (0.00823)	-0.00684 (0.00716)	-0.00984** (0.00468)	-0.0756** (0.0374)	-0.0593** (0.0301)	-0.000803 (0.0262)	-0.0101 (0.0273)	0.000312 (0.0226)	-0.0177 (0.0168)
Mean Net Provision Income (0)	0.0250 (0.0190)	0.00640 (0.00975)	-0.00305 (0.00272)	-0.00554 (0.00340)	0.00103 (0.00733)	-0.000320 (0.00283)	0.106 (0.0727)	0.0596 (0.0459)	0.0221 (0.0366)	-0.00671 (0.0372)	-0.00507 (0.0339)	0.0371* (0.0190)
Mean Net Trading Income (0)	0.340** (0.159)	0.195*** (0.0704)	-0.0632 (0.105)	0.0647 (0.101)	0.169* (0.0910)	-0.0209 (0.0570)	0.303 (0.288)	0.315** (0.157)	-0.306 (0.265)	0.0584 (0.163)	0.173 (0.171)	-0.150 (0.121)
Mean Cost-Income-Ratio (0)	-0.0529** (0.0235)	-0.0394*** (0.0123)	-0.0295*** (0.0105)	-0.0272* (0.0139)	-0.0302*** (0.00988)	0.00518 (0.00630)	-0.194 (0.157)	-0.107 (0.113)	-0.0997 (0.108)	-0.0858 (0.0932)	0.0354 (0.0836)	-0.0194 (0.0647)
Mean Loss Provisions (0)	-0.0103 (0.0136)	0.00226 (0.00631)	-0.00609 (0.00676)	-0.00269 (0.00841)	-0.00632 (0.00616)	0.00356 (0.00221)	-0.0252 (0.0204)	0.0451 (0.0662)	-0.0249** (0.0108)	-0.0762 (0.0695)	-0.0377 (0.0500)	0.00666 (0.00477)

Standard errors in parentheses

* p<0.1, ** p<0.05, *** p<0.01

Table 4: Descriptive Statistics of key mean variables

This table presents the descriptive statistics of our key explanatory mean variables. **Mean** indicates that the respective variable is calculated as the simple average over the respective time period, i.e. (0) refers to the time period between January 2004 to August 2007 and 2004/2005 to the time period between January 2004 to December 2005. The latter is provided since we use these structural means in Model 4(a) and Model 4(b). Note: except for the Cost-income-Ratio, all profit and loss measures are calculated relative to the average total assets observed from the balance sheet statistic; **SD** refers to the standard deviation and **IQR** is the the interquartile range formed by Q75 - Q25.

	January 2006 - August 2007			Subprime			Lehman		
	Mean	SD	IQR	Mean	SD	IQR	Mean	SD	IQR
Liquidity Mean Variables									
Mean Liquidity Risk (0)	0.56	9.17	0.15	0.70	11.12	0.15	0.65	10.79	0.15
Mean Fulfillment Ratio (0)	0.55	14.12	0.05	0.83	19.51	0.05	0.77	19.15	0.05
Mean MDF (0)	0.03	0.83	0.00	0.04	1.02	0.00	0.03	0.84	0.00
Mean DIST (0)	0.94	0.03	0.02	0.94	0.03	0.02	0.94	0.03	0.02
Mean Liquidity Risk (2004/2005)	0.95	19.90	0.15	1.07	21.10	0.15	0.93	18.78	0.15
Mean Fulfillment Ratio (2004/2005)	0.95	25.39	0.05	1.10	26.54	0.05	0.90	22.33	0.05
Mean MDF (2004/2005)	0.04	0.97	0.00	0.04	0.99	0.00	0.04	0.99	0.00
Mean DIST (2004/2005)	0.87	0.11	0.05	0.86	0.11	0.06	0.86	0.12	0.19
Balance sheet Mean Variables									
Mean Size in '000 (0)	3284990	1.96E+07	982175.1	3320339	1.98E+07	992491.2	3226191	1.98E+07	991372
Mean Equity Ratio (0)	0.06	0.04	0.02	0.06	0.04	0.02	0.06	0.05	0.02
Mean Interbank Obligations (0)	0.17	0.14	0.11	0.17	0.15	0.11	0.17	0.14	0.11
Mean Size in '000 (2004/2005)	3170160	1.90E+07	957408.7	3211587	1.92E+07	974850.7	3121449	1.93E+07	976155
Mean Equity Ratio (2004/2005)	0.06	0.04	0.02	0.06	0.04	0.02	0.06	0.05	0.02
Mean Interbank Obligations (2004/2005)	0.18	0.15	0.11	0.18	0.15	0.11	0.18	0.15	0.11
Profit/Loss Mean Variables									
Mean Net Interest Income (0)	0.03	0.01	0.00	0.03	0.01	0.00	0.03	0.01	0.00
Mean Net Provision Income (0)	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Mean Net Trading Income (0)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean Cost-Income-Ratio (0)	0.74	0.33	0.12	0.74	0.33	0.12	0.74	0.33	0.12
Mean Loss Provisions (0)	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Post-Lehman									
	Mean	SD	IQR	Mean	SD	IQR	Mean	SD	IQR
Liquidity Mean Variables									
Mean Liquidity Risk (0)	0.62	10.23	0.15	0.64	10.35	0.15	0.64	10.39	0.15
Mean Fulfillment Ratio (0)	0.73	18.56	0.05	0.76	18.79	0.05	0.77	18.87	0.05
Mean MDF (0)	0.05	1.36	0.00	0.05	1.37	0.00	0.05	1.37	0.00
Mean DIST (0)	0.94	0.03	0.02	0.94	0.03	0.02	0.94	0.03	0.02
Mean Liquidity Risk (2004/2005)	0.74	14.19	0.15	0.75	14.34	0.15	0.75	14.40	0.15
Mean Fulfillment Ratio (2004/2005)	0.63	13.18	0.05	0.65	13.39	0.05	0.65	13.44	0.05
Mean MDF (2004/2005)	0.04	1.02	0.00	0.05	1.03	0.00	0.05	1.04	0.00
Mean DIST (2004/2005)	0.86	0.12	0.19	0.86	0.12	0.20	0.86	0.12	0.20
Balance Sheet Mean Variables									
Mean Size in '000 (0)	3141818	1.88E+07	998967.7	3.07E+06	18200000	1033040	3085068	18300000	1.04E+06
Mean Equity Ratio (0)	0.06	0.05	0.02	0.06	0.05	0.02	0.06	0.05	0.02
Mean Interbank Obligations (0)	0.17	0.14	0.11	0.17	0.14	0.11	0.17	0.14	0.11
Mean Size in '000 (2004/2005)	3032506	1.82E+07	980923.7	2.95E+06	17500000	994539.9	2969952	17500000	1.01E+06
Mean Equity Ratio (2004/2005)	0.06	0.05	0.02	0.06	0.05	0.02	0.06	0.05	0.02
Mean Interbank Obligations (2004/2005)	0.18	0.15	0.11	0.18	0.15	0.11	0.18	0.15	0.11
Profit/Loss Mean Variables									
Mean Net Interest Income (0)	0.03	0.01	0.00	0.03	0.01	0.00	0.03	0.01	0.00
Mean Net Provision Income (0)	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00
Mean Net Trading Income (0)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean Cost-Income-Ratio (0)	0.74	0.33	0.12	0.74	0.38	0.12	0.74	0.34	0.12
Mean Loss Provisions (0)	0.01	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00

Figure 2: Predictive margins at different representative states for the key explanatory mean variables for model 1(a) (*All banks*) over the time period August 2007 to October 2010 (i.e. for the *All periods* regression of model 1(a)). The dotted lines depict 95% confidence intervals. The confidence intervals are estimated using robust standard errors to account for heteroskedasticity and are truncated at zero and one.

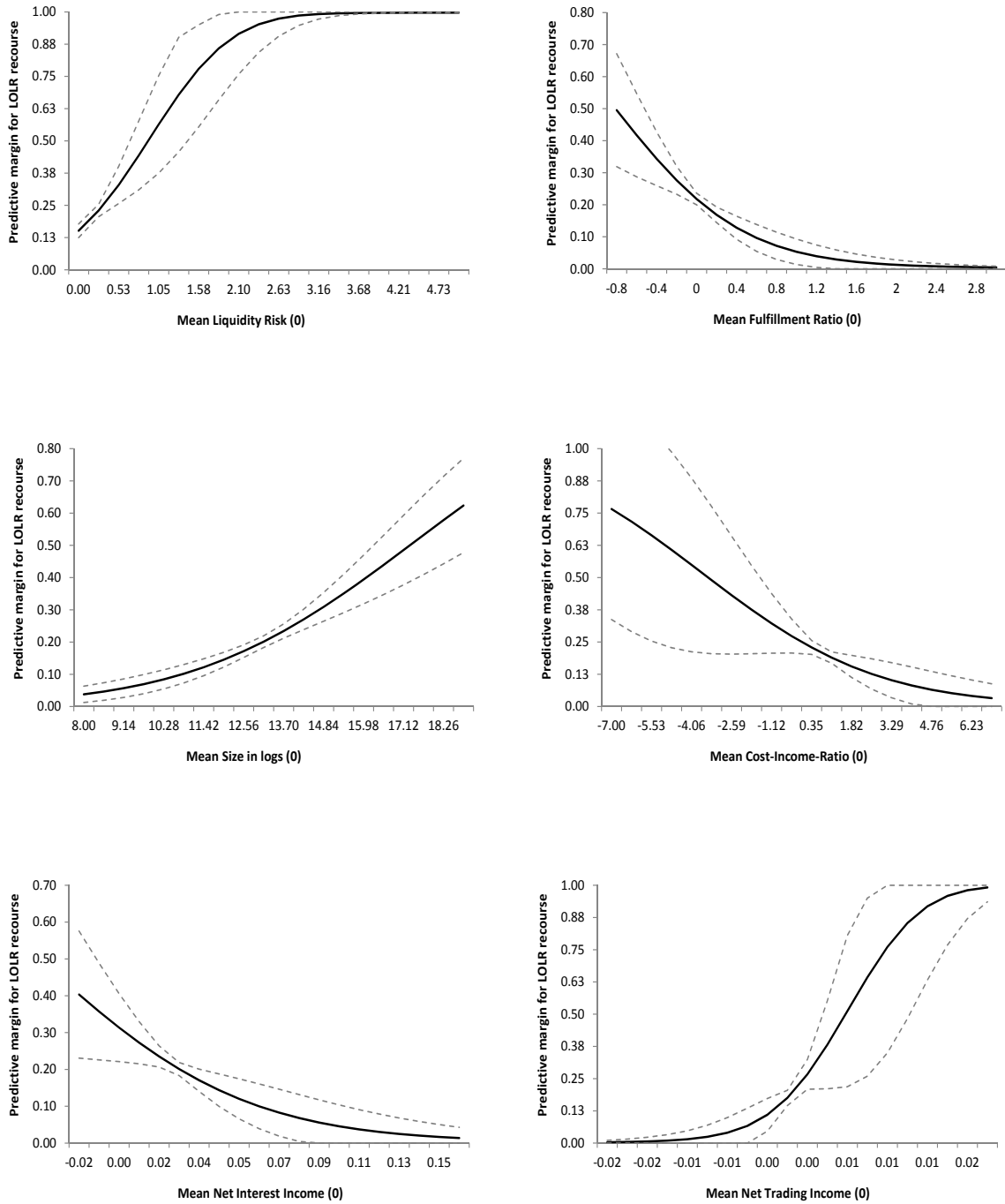


Table 5: Main Results II - MLF amount estimation with Heckman correction

This table presents the empirical results for Model 2(a) and Model 2(b) using the Heckman correction to estimate the ultimate Euro amount that a bank will draw from the discount window of the Eurosystem. The dependent variable is the nominal MLF amount in Euro. All independent Mean ... (0) variables are calculated as simple means for the pre-crisis period January 2004 to August 2007. The bidding banks regression, Model 2(b), only considers those banks which participated at least once in a main refinancing operation before August 2007. Due to space restrictions, the coefficients from the selection equation, and the dummy for the last day of a RMP are omitted from this table.

	Model 2(a) (All banks)				Model 2(b) (Bidding banks only)					
	All periods	Subprime	Lehman	Post-Lehman	Sovereign	All periods	Subprime	Lehman	Post-Lehman	Sovereign
Outcome equation										
Mean Liquidity Risk (0)	164462607.5*** (39468382.2)	42639641.3 (28610254.7)	-9593760.6 (87654058.1)	478574354.7*** (131571494.3)	187259805.7** (95371748.9)	555014293.1*** (119216179.5)	43505769.2 (88164869.8)	507101281.6** (231063667.0)	837278379.1** (406529545.1)	902709035.3*** (314327524.8)
Mean Fulfillment Ratio (0)	-229607210.5*** (51264436.4)	-57937476.7 (35591867.2)	-64643080.7 (131777874.1)	-656220969.6*** (174406118.1)	-428606340.6*** (151982004.6)	(1.39811e+09) (1.519***	(1.18042e+09) (0.404	(2.71452e+09) (1.281**	(5.67612e+09) (1.217	(4.61113e+09) (3.535***
Mean DIST (0)						3.32405e+09** (1.39811e+09)	200246465.5 (1.18042e+09)	2.71962e+09 (2.71452e+09)	7.61677e+09 (5.67612e+09)	7.65107e+09* (4.61113e+09)
Mean Size (0)	1.413*** (0.307)	0.552** (0.224)	0.831 (0.541)	1.260 (1.000)	2.049** (0.820)	(0.421) (0.421)	(0.333) (0.333)	(0.648) (0.648)	(1.393) (1.393)	(1.124) (1.124)
Mean Equity Ratio (0)	-440941323.8*** (139774173.1)	39388155.3 (98187646.1)	-527342678.9 (398259782.0)	-751896669.8 (489207370.9)	27877928.0 (489637676.5)	-439335134.3 (270159508.6)	67300415.1 (185957654.5)	-1.41875e+09** (690929994.8)	-736446928.1 (959449209.8)	-1.11085e+09 (978757466.0)
Mean Interbank Obligations (0)	-215169127.5*** (74664315.6)	-50071303.9 (48277592.8)	321656676.8* (186268486.6)	-209521636.4 (300590063.2)	37625817.4 (239482245.1)	-385183812.1** (168138572.4)	22529967.1 (292322795.5)	99020527.1 (292322795.5)	-232126569.5 (561832738.1)	-1.26540e+09** (56234533.5)
Mean Net Interest Income (0)	-3.03368e+09 (1.89867e+09)	-3.73390e+09*** (1.35835e+09)	5.35113e+09 (5.51541e+09)	-2.30816e+09 (6.07227e+09)	-4.64116e+09 (4.34789e+09)	-1.55527e+09 (3.91192e+09)	-6.48431e+09** (2.90444e+09)	-1.18473e+10 (8.79469e+09)	-4.76243e+09 (1.44347e+10)	-5.56775e+09 (1.24547e+10)
Mean Net Provision Income (0)	-780958690.5 (705971813.2)	-461164851.7 (447432017.9)	1.4287e+09 (3.07050e+09)	-1.111106e+09 (4.61406e+09)	6.02605e+09* (3.43634e+09)	-1.50623e+09 (5.06313e+09)	2.30297e+09 (3.56394e+09)	9.66666e+09 (1.37690e+10)	9.40080e+09 (2.02241e+10)	-6.18530e+10 (1.25135e+10)
Mean Net Trading Income (0)	-1.92542e+10 (1.17637e+10)	3.77925e+09 (7.94751e+09)	-3.89109e+10 (4.63169e+10)	1.30728e+10 (4.07113e+10)	-4.74026e+10* (2.49770e+10)	-2.23965e+10 (1.8210e+10)	-1.17758e+10 (1.81388e+10)	-2.04919e+11** (8.52117e+10)	9.40080e+09 (6.60426e+10)	-6.18530e+10 (3.97048e+10)
Mean Cost-Income-Ratio (0)	-27074459.3* (15717895.9)	990734.4 (11430382.4)	11538697.1 (40533191.6)	-79013689.2 (51370243.6)	-19864737.3 (51370243.6)	-314501935.7*** (105420322.4)	-62270815.0 (847787892.1)	157161885.8 (277487892.1)	14981230.1 (344726998.1)	-2681168022.2 (268311472.2)
Mean Loss Provisions (0)	1.29396e+09 (1.85421e+09)	-604580928.1 (1.22796e+09)	8.58593e+09 (8.03520e+09)	1.10825e+10 (1.19866e+10)	2.10888e+10* (9.71496e+09)	-4720033.0 (2.69535e+09)	-827878385.8 (1.74975e+09)	8.03364e+10*** (2.18493e+10)	5.37660e+10 (3.32371e+10)	4.43377e+10* (2.61991e+10)
Constant	403627470.7*** (136587642.8)	-37204154.5 (99179680.3)	961976424.7*** (243439455.7)	252106144.1 (346313358.8)	346600938.8 (305889043.7)	-3.24885e+09** (1.33855e+09)	-181320278.1 (1.13087e+09)	-2.37295e+09 (2.54588e+09)	-7.32691e+09 (5.37784e+09)	-7.55061e+09* (4.36808e+09)
Selection equation										
Mean Liquidity Risk (0)	0.523*** (0.0225)	0.683*** (0.0388)	0.503*** (0.0552)	0.472*** (0.0471)	0.459*** (0.0513)	0.899*** (0.0552)	1.249*** (0.107)	0.769*** (0.130)	0.794*** (0.108)	0.860*** (0.132)
Mean Fulfillment Ratio (0)	-0.626*** (0.0297)	-0.797*** (0.0501)	-0.552*** (0.0649)	-0.557*** (0.0626)	-0.600*** (0.0693)	1.62e-09*** (3.52e-10)	-6.86e-11 (6.58e-10)	2.83e-09*** (8.05e-10)	2.84e-09*** (6.98e-10)	2.18e-09*** (8.34e-10)
Mean DIST (0)						0.121 (0.153)	-0.389 (0.978)	-1.266 (1.139)	0.138 (1.153)	0.908 (1.375)
Mean Size (0)	1.98e-09*** (3.30e-10)	8.12e-11 (6.12e-10)	3.34e-09*** (7.54e-10)	3.15e-09*** (6.53e-10)	2.69e-09*** (7.68e-10)	1.62e-09*** (3.52e-10)	6.58e-10 (6.58e-10)	8.05e-10 (8.05e-10)	6.98e-10 (6.98e-10)	8.34e-10 (8.34e-10)
Mean Equity Ratio (0)	0.803*** (0.134)	1.550*** (0.193)	0.0791 (0.503)	0.0858 (0.317)	-0.0704 (0.380)	0.946*** (0.185)	1.477*** (0.289)	0.568 (0.636)	0.513 (0.408)	-0.539 (0.580)
Mean Interbank Obligations (0)	-0.272*** (0.0722)	-0.212* (0.121)	-0.198 (0.176)	-0.467*** (0.152)	-0.352** (0.173)	-0.359*** (0.112)	-0.490** (0.201)	0.0430 (0.245)	-0.622*** (0.223)	-0.585** (0.290)
Mean Net Interest Income (0)	-9.467*** (1.046)	-14.12*** (1.806)	-13.15*** (3.263)	-5.570*** (2.002)	-2.096 (2.171)	-12.45*** (2.549)	-14.17*** (4.873)	-9.588 (6.858)	-1.320 (5.167)	1.428 (6.015)
Mean Net Provision Income (0)	-4.562*** (0.604)	-9.000*** (1.041)	-3.359*** (1.202)	-3.461*** (0.999)	-2.098*** (0.763)	1.611 (3.250)	4.194 (5.693)	-0.412 (9.886)	-3.278 (6.708)	1.982 (6.708)
Mean Net Trading Income (0)	-36.37*** (10.51)	-28.73* (17.02)	-104.6*** (38.08)	-63.99*** (23.40)	-5.453 (20.75)	-24.41 (17.86)	-17.19 (34.50)	-83.81 (60.43)	-50.81 (35.40)	12.35 (31.16)
Mean Cost-Income-Ratio (0)	-0.103*** (0.0117)	-0.0771*** (0.0184)	-0.176*** (0.0345)	-0.114*** (0.0263)	-0.149*** (0.0310)	-0.502*** (0.0770)	-0.505*** (0.140)	-1.255*** (0.200)	-0.469*** (0.156)	-0.242 (0.186)
Mean Loss Provisions (0)	-1.589 (0.981)	-1.117 (1.444)	-4.915 (3.864)	-1.639 (2.117)	-2.817 (2.918)	-7.203*** (1.871)	-6.462*** (2.261)	-56.31*** (18.14)	-56.27*** (15.11)	-36.72** (16.01)
Constant/BGR/Last day of RMP	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
Mills lambda	-84650162.1* (47502301.7)	40898538.2 (30875431.5)	-355300969.9*** (112884117.0)	-78730198.0 (126668588.0)	-92197793.7 (101393817.6)	97145290.7 (63596500.9)	51529757.0 (39040068.7)	-158231025.5 (159122759.1)	-33606508.4 (190401643.8)	114678012.1 (146327396.6)
Observations	1382785	487777	157570	342403	354178	1382235	487590	157456	342272	354073

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table 6: Main Results III - Modeling the probability of a MLF recourse using structural factors and controls on a contemporary basis

This table presents the empirical results for Model 3(a) and Model 3(b) using a panel probit model. All variables, including the binary dependant variable *MLF-Recourse*, are included on a day-by-day basis and the regressions are estimated using reserve-maintenance-period specific time fixed effects. The dependant variable is equal to 1 at time t if a MLF recourse is observed on that day and zero otherwise. All independent Mean ... (0) variables are calculated as simple averages for the pre-crisis period January 2004 to August 2007. The bidding banks regression only considers those banks which participated at least once in a main refinancing operation before August 2007. Due to space restrictions, the coefficients from the banking group dummy variables (BGR), the constant, and the TFEs are omitted from this table. Note that because of computational restrictions, TFE were not estimated for the *All Periods* outcome.

	Model 3(a) (All banks in the sample)					Model 3(b) (Bidding banks only)						
	All periods	Subprime	Lehman	Post-Lehman	Sovereign	P. Sovereign	All periods	Subprime	Lehman	Post-Lehman	Sovereign	P. Sovereign
Mean Variables												
Mean Liquidity Risk (0)	0.484*** (0.0948)	0.826*** (0.132)	0.669*** (0.187)	0.640*** (0.145)	0.827*** (0.159)	0.892*** (0.286)	1.162*** (0.216)	1.616*** (0.271)	1.226*** (0.449)	1.177*** (0.357)	1.336*** (0.373)	0.983*** (0.464)
Mean Fulfillment Ratio (0)	-0.609*** (0.133)	-1.107*** (0.186)	-0.743*** (0.222)	-0.850*** (0.214)	-1.274*** (0.252)	-0.748* (0.389)	0.0393 (0.0393)	0.0805** (0.0393)	4.93e-10 (1.62e-09)	2.77e-09 (2.76e-09)	2.02e-09 (2.55e-09)	-1.31e-09 (2.73e-09)
Mean MDF (0)	0.0204 (0.0162)	0.0256 (0.0202)	-0.0209 (0.0375)	0.0214 (0.0257)	-1.257* (0.705)	-0.950 (1.317)						
Mean DIST (0)												
Mean Size in logs (0)	0.128*** (0.0218)	1.30e-09 (1.95e-09)	5.63e-09* (3.23e-09)	4.33e-09* (2.44e-09)	2.89e-09 (2.55e-09)	-1.73e-09 (3.26e-09)						
Mean Equity Ratio (0)	0.878 (0.562)	0.754 (0.735)	1.046 (1.199)	-0.0904 (0.879)	0.444 (0.865)	0.756 (1.544)						
Mean Interbank Obligations (0)	-0.315 (0.225)	-0.248 (0.337)	-0.177 (0.480)	-0.567 (0.349)	-0.785* (0.430)	-0.168 (0.737)						
Mean Net Interest Income (0)	-8.705*** (3.338)	-16.89*** (4.951)	-13.67* (7.741)	-10.11** (5.145)	-5.339 (5.533)	-25.69** (11.87)						
Mean Net Provision Income (0)	-1.589 (1.358)	-4.224** (1.668)	-3.988 (3.193)	-3.835* (2.199)	3.772 (4.707)	-0.529 (7.653)						
Mean Net Trading Income (0)	19.56 (34.14)	56.04 (45.63)	-66.95 (83.51)	-30.21 (48.89)	31.70 (53.00)	-55.67 (111.4)						
Mean Cost-Income-Ratio (0)	-0.174*** (0.0592)	-0.235*** (0.0786)	-0.249** (0.114)	-0.234*** (0.0844)	-0.279*** (0.0938)	0.0225 (0.147)						
Mean Loss Provisions (0)	-0.684 (3.393)	-0.0405 (4.417)	-4.191 (8.765)	-2.041 (5.476)	-6.251 (7.342)	1.752 (5.242)						
Contemporary Variables												
Liquidity Risk	0.0130*** (0.00248)	0.0102** (0.00422)	-0.00141 (0.00772)	0.0127 (0.00901)	0.0158** (0.00634)	-0.0779 (0.133)	0.0319*** (0.00798)	0.0107 (0.0317)	0.114** (0.0470)	0.0115 (0.0397)	0.0243* (0.0126)	-0.241 (0.190)
Net Excess Reserves	-0.0122*** (0.00196)	-0.00199 (0.00286)	-0.00613** (0.00264)	-0.0214** (0.00869)	-0.0400*** (0.00642)	-0.171** (0.0754)						
Liquidity Imbalances	4.42e-10*** (1.01e-10)	-7.83e-10 (5.69e-10)	-5.68e-10 (3.59e-10)	2.07e-10 (3.54e-10)	8.10e-10*** (1.72e-10)	1.46e-10 (9.60e-10)	2.71e-10* (1.47e-10)	-9.99e-10 (7.77e-10)	-4.85e-11 (4.49e-10)	1.43e-12 (5.19e-10)	5.82e-10** (2.63e-10)	6.19e-09* (3.49e-09)
Volatility overnight Repo rate	0.728*** (0.158)	1.315** (0.521)	0.746* (0.409)	-0.252 (0.340)	-1.525* (0.911)	-2.468 (7.899)	0.820*** (0.212)	0.850 (0.693)	0.978* (0.543)	-0.151 (0.457)	-1.493 (1.243)	-7.191 (8.874)
Counterparty Credit Risk	0.461*** (0.0765)	0.493*** (0.180)	0.255 (0.330)	0.971*** (0.147)	0.973 (0.760)	3.961*** (6.591)	0.416*** (0.101)	0.984*** (0.244)	0.134 (0.432)	0.986*** (0.213)	0.0507 (1.107)	0.966 (1.644)
Distance MLF Europe	0.0625 (0.0386)	0.261 (0.245)	0.0953 (0.0987)	-0.431*** (0.148)	-2.356*** (0.907)	-6.591 (4.085)	0.167*** (0.343)	0.523 (0.343)	0.114 (0.142)	-0.566*** (0.210)	-1.949 (1.284)	0.596 (6.002)
German Fixed Income Volatility	0.293*** (0.0401)	0.190 (0.132)	0.0955 (0.171)	-0.0998 (0.171)	0.465 (0.293)	2.669 (1.633)	0.381*** (0.0525)	0.274 (0.173)	0.0848 (0.121)	-0.152 (0.232)	0.307 (0.386)	0.650 (1.909)
ECB Liquidity Policy Indicator	-0.0694** (0.0275)	-0.543*** (0.182)	-0.358* (0.198)	-0.118 (0.105)	0.378*** (0.141)	2.608 (2.123)	-0.104*** (0.0376)	-0.561** (0.243)	-0.691** (0.270)	0.102 (0.154)	0.297 (0.201)	5.980* (3.333)
Last day of reserve maintenance period	0.509*** (0.0313)	0.866*** (0.0607)	0.327** (0.161)	0.506*** (0.0634)	0.536** (0.258)	0.674 (0.829)	0.715*** (0.0398)	1.099*** (0.0774)	0.600*** (0.207)	0.712*** (0.0844)	1.074*** (0.376)	-0.450 (1.301)
Summary Statistics												
Time Fixed Effects (TFE)	no	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes
Observations	1331922	472232	152034	329680	339746	39038	413604	145926	47074	102363	106013	12233
Avg. Observations per ID	761	270.2	89.64	195.0	206.0	23.95	766	270.2	89.32	195.3	205.9	23.99
Deg. of fre. (model)	26	39	29	35	36	27	24	38	28	34	34	25
Log likelihood	-8488.4	-2598.0	-1583.3	-2078.3	-1592.8	-248.6	-4791.7	-1494.3	-861.0	-1108.7	-857.1	-156.6

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Table 7: Robustness Result - Modeling the MLF recourse for the pre-crisis time using structural factors calculated over the tranquil phase 01/2004 - 12/2005

This table presents the empirical results for Model 4(a) and 4(b) for the key liquidity and balance sheet variables calculated over the period January 2004 to December 2005 using a pooled probit regression with robust standard errors for estimating the likelihood that a bank will use the MLF of the Eurosystem. Since we have not sufficient data points to construct meaningful structural means for the profit and loss measures, we exclude these variables in Model 4 completely. The key column in this table is "2006/2007", which shows the results of how our key explanatory variables, calculated over the tranquil period January 2004 - December 2005, performed in predicting a MLF recourse for the also tranquil period between January 2006 - August 2007. The dependent variable is equal to 1 for a single bank if at least one MLF recourse was observed in the respective time period. The bidding banks regression, Model 4(b) only considers those banks which participated at least once in a main refinancing operation before the end of December 2005. Due to space restrictions, the coefficients from the banking group dummy variables (BGR) are omitted from this table.

	Model 4(a) (All banks in the sample)					Model 4(b) (Bidding banks only)						
	2006/2007	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign	2006/2007	Subprime	Lehman	Post-Lehman	Sovereign	Post-Sovereign
Liquidity Mean Variables												
Mean Liquidity Risk (2004/2005)	0.158** (0.0757)	0.310*** (0.0831)	0.125 (0.0868)	0.756*** (0.170)	0.856*** (0.180)	0.449** (0.213)						
Mean Fulfillment Ratio (2004/2005)	-0.195** (0.0911)	-0.379*** (0.100)	-0.154 (0.104)	-0.920*** (0.206)	-1.099*** (0.292)	-0.976** (0.419)						
Mean MDF (2004/2005)	0.105 (0.0785)	0.0562 (0.0428)	0.0240 (0.0496)	-0.0417 (0.0747)	-0.475 (0.519)	-0.697 (1.962)						
Mean DIST (2004/2005)							0.237 (0.667)	-0.311 (0.637)	-1.020 (0.651)	-0.322 (0.676)	0.740 (0.766)	-0.653 (0.928)
Balance Sheet Mean Variables												
Mean Size in logs (2004/2005)	3.69e-09 (2.64e-09)	6.27e-09* (3.73e-09)	7.00e-09* (3.76e-09)	8.02e-09** (3.78e-09)	6.79e-09* (3.84e-09)	-1.01e-09 (4.04e-09)	1.21e-09 (2.81e-09)	2.52e-09 (3.41e-09)	5.32e-09 (3.83e-09)	6.59e-09* (3.75e-09)	4.45e-09 (3.75e-09)	-1.98e-09 (4.05e-09)
Mean Equity Ratio (2004/2005)	1.144 (0.931)	0.421 (0.946)	1.308 (1.012)	-1.117 (1.104)	0.674 (1.059)	1.050 (1.301)	0.796 (1.887)	0.268 (2.015)	1.204 (2.008)	1.250 (2.095)	1.390 (1.985)	0.358 (2.099)
Mean Interbank Obligations (2004/2005)	0.461 (0.326)	0.685** (0.336)	0.686* (0.364)	-0.276 (0.366)	-0.230 (0.406)	0.501 (0.584)	0.242 (0.619)	0.348 (0.643)	0.796 (0.672)	-0.267 (0.667)	-0.300 (0.710)	0.0320 (0.930)
BGR	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted	omitted
Constant	-1.038 (0.778)	-2.242* (1.174)	-2.984** (1.242)	-1.734 (1.235)	-1.692 (1.235)	-1.169*** (0.436)	-0.346 (1.038)	-0.709 (1.156)	-1.589 (1.348)	-0.788 (1.343)	-1.277 (1.363)	0.137 (0.903)
Summary Statistics												
Observations/No. of banks	1861	1790	1737	1733	1689	1667	528	516	503	502	492	485
Deg. of fre. (model)	12	11	11	12	12	11	11	10	10	11	11	10
Log likelihood	-383.5	-405.7	-412.4	-486.1	-374.4	-148.4	-198.9	-197.8	-167.0	-165.7	-152.0	-79.44
Pseudo R2	0.251	0.257	0.117	0.126	0.160	0.198	0.164	0.229	0.162	0.197	0.185	0.238

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01