The Role of Interbank Relationships and Liquidity Needs*

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Abstract

In this paper, we study to what extent peer monitoring or more precisely relationship lending prevails in the German interbank market. In particular, we empirically investigate whether interbank relationships help banks to smooth liquidity shocks. We find that banks that have a higher number of bank relationships in the interbank market bid less aggressively in an ECB auction. However those banks with diversified borrowing structures are also more likely to participate in the auction. This suggests that while the decision of participating in an auction is driven by the degree of interbank relationships, bidding behavior is determined by the diversification of bank liquidity risk.

Keywords: Interbank markets, liquidity, relationship lending, networks

JEL Codes: G21, E58, D44, L14, D85

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1 Introduction

A key strategy of the G20 for strengthening financial stability is to focus tighter regulatory requirements on systemically important financial institutions. These intermediaries are typically considered to be too big or too connected to fail and the recommended regulatory changes strive at containing the moral hazard resulting from the implicit insurance of investors. This strategy requires that regulators identify the systemically important financial institutions. Clearly, one important indicator for the costs that a failure of a financial institution imposes on the rest of the financial system is the amount of outstanding liabilities to the rest of the financial sector. This provides a rough measure of the credit risk born by other financial institutions and thus helps to appraise the potential externality effects of a failure. Indeed, many of the current recommendations include a measure of claims held against other financial institutions.[1] But this leaves open the question of why the failure of a large financial institution also imposes costs on its borrowers, particularly those in the financial system.

The key reason that borrowers in the interbank market can suffer from a failure of their lender lies in the fact that relationships and private information matter. Rochet and Tirole (1996), for instance, argue that private information and peer monitoring in interbank markets is important to implement market discipline. If private information acquired through lending relationship allows an interbank bank lender to better assess the credit risk of his counterpart, borrowers of good quality should receive cheaper funding from their interbank relationship lender than from other banks. This means that a failure of an interbank relationship lender incurs the cost of the loss of valuable private information and an increase in the funding costs of its borrowers which might ultimately even lead to their failure. Consequently, if relationship lending prevails in interbank markets, financial contagion not only affects lenders through

[1] See, for example, Basel Committee on Banking Supervision (2011).

credit default, but also endangers the stability of borrowers. The question is to what extent private information and relationship lending in the interbank market really matter.

In this paper, we focus on the connection between the relationship lending externality and the price paid for liquidity. The observed structure of all borrowing in the interbank market forms a proxy for the unobservable relationship-lender externalities. Our paper is related to a number of empirical studies that also investigate the implications of private information and relationship lending in the interbank market. Cocco, Gomes and Martins (2009) find evidence for the Portuguese interbank market that weaker banks rely to a larger extent on lending relationships and pay lower rates for liquidity when borrowing from their relationship lender. More recently Afonso, Kovner and Schoar (2011) study relationship lending in the federal funds market. They find that riskier and more opaque borrowers have concentrated lending relationships. Concentrated borrowers can easily get funds when needed and pay a significantly lower rate to their relationship lender than they pay when borrowing from other market participants. Our analysis is different from these studies in that we focus on the bidding behaviour of banks in the primary market and how their relationships in the interbank market influence this behaviour.

Theoretical models in a bank-firm context hypothesize that bank monitoring incentives lead to concentrated corporate borrowing (Holmstrom and Tirole (1997)) or to multiple banking whenever the benefit of greater diversification dominates the costs of free-riding (Carletti, Cerasi and Daltung (2007)). If concentrated borrowing leads to lower interbank borrowing rates[2] (which we do not observe in our data), that would be reflected in lower rates banks are willing to bid for liquidity at the repo-auctions held by the central bank. However, the borrowing structure is also determined by the financial health of the lender where multiple banking allows firms to diversify bank liquidity risk (see Detragiache, Garella and Guiso (2000) and Ongena, Tümer-Alkan, and von Westerhagen (2011)). In that respect,

[2] See Braeuning (2011) for a study on the German interbank borrowing rates.

diversification incentives would suggest an inverse (positive) relationship between borrowing concentration and banks' liquidity needs (the willingness to bid).

We examine the empirical importance of relationship lending in the German interbank short-term liquidity market. We use quarterly data from 1999 to 2007 of bilateral interbank credit exposures between all German banks from the credit register data of the Deutsche Bundesbank to measure interbank relationships. We match these data with the bids placed by the individual banks in the European Central Bank's (ECB) weekly repo auctions. Since the main refinancing operations were held during our sample period as variable rate tenders and as 'pay-your-bid' auctions they reveal individual banks' willingness to pay for liquidity. Controlling for bank characteristics, we find that banks with a more concentrated borrowing structure in the interbank market bid significantly more aggressively in the ECB's refinancing operations. In particular, when short in liquidity to fulfil their reserve requirements, banks with fewer interbank lenders place significantly higher bids in the auctions than banks with a higher number of interbank lenders. This suggests that concentrated borrowers have to pay a premium when they require funding from interbank lenders other than their relationship lender. These findings also show that private information and relationship lending are indeed important in the interbank market.

The remainder of the paper is organized as follows. In section 2, we describe the data, our empirical strategy and our hypotheses. We investigate the impact of interbank relationships on the bidding behaviour in auctions and present the estimation results in the third section. Section 4 concludes.

2 Data and Variables

2.1 Data Sources

We employ a unique matched dataset covering the time period from 1999 to 2007. The data are obtained by matching four major databases provided by the Deutsche Bundesbank containing information on banks' bidding behaviour in the primary market, interbank relationships, as well as balance sheet items and reserve data to control for bank characteristics and liquidity needs.

We measure banks' willingness to pay for liquidity by their bids placed in the European Central Bank's (ECB) weekly repo auctions (see Craig and Fecht (2007), Fecht, Nyborg and Rocholl (2011), Nyborg, Bindseil and Strebulaev (2002), Linzert, Nautz and Bindseil (2007) and Linzert, Nautz and Breitung (2006)). The data on German banks are compiled by the Deutsche Bundesbank as all monetary operations in the Eurosystem are conducted at the national level. We include the complete set of bids for all main refinancing operations that are variable rate tenders held in our sample period.[3] The sample of auctions consists of 438 main refinancing operations with maturities of seven and fourteen days.

The Deutsche Bundesbank's credit register (*MiMik*) is the second data source of our analysis to measure the individual exposures of German banks to financial and non-financial firms. The credit register contains information on large exposures of 1.5 million Euros (formerly 3 million DM) and above. German banks are required to report their exposures exceeding this reporting threshold to the Deutsche Bundesbank on a quarterly basis.[4] We are able to identify both the borrower and the lender with a full counter-party breakdown, borrower identity, location, industry, legal form and the date of bankruptcy (if applicable).

[3] The ECB decided to change its auction procedure to fixed rate tender on 8 October 2008.
[4] For a more detailed definition, see Section 14 of the Banking Act (Deutsche Bundesbank, 2001). If the sum of the exposures to firms in a borrower unit exceeds the threshold, the individual exposures in that borrower unit are reported, even if it is a small exposure. For claims existed during the reporting period but are partly or fully repaid, the remaining exposure is reported even if the amount is zero. This helps us to identify the existing bilateral relationships.

Moreover, we can distinguish short-term exposures for interbank loans as well as on-balance sheet and off-balance sheet items. Since we are interested in bilateral bank relationships, we only include exposures to banks, and investigate at each borrower level in order to observe the borrowing patterns in the interbank market. We match this dataset of borrower banks and their relationship structure with bank balance sheet data (*BISTA*) that include all banks in the German banking system. In addition to investigating the borrowing patterns, we include information on financial networks to be able account for systemic importance in terms of both intermediation and tiering in the interbank market (see Craig and von Peter, 2010).[5]

Finally, we employ reserve data for all German financial institutions in the industry available from 2004 to 2007. The data involves each bank's cumulative reserve holdings on a daily basis, and the reserve requirement for each maintenance period. After matching credit register data and bank balance sheet statistics, we match these data with the set of bids aggregated at bidder level. The final match involves combining the fourth dataset on reserves with the previously matched unique data.

2.2 Variable Definitions

We first group our variables based on the data sources. All variable definitions and summary statistics are displayed in Table 1. We further categorize the set of dependent variables as *Pricing*; explanatory variables as *Relationship* and *Network* measures, *Balance Sheet* variables and *Liquidity needs* (obtained from both auction data and reserve data) to control for bank characteristics, and *Auction* characteristics.

2.2.1 Pricing and performance measures

Our major interest is to measure the bidding behaviour, in particular the aggressiveness of banks in repo auctions. By constructing our variables, we mainly follow the approach by

[5] Previous studies employ either payment data or balance sheet data to estimate interbank positions (see Furfine (2003), Bech and Atalay (2010) and Upper and Worms (2004) among others).

Fecht, Nyborg and Rocholl (2011) who explain auction pricing with bank and market characteristics.

We employ three measures computed using the bidding data. The first two concerns the pricing pattern. First, we calculate the *Overbid* (*Overpricing*) for each bidder by subtracting the Eonia swap rate from the weighted average bid (paid). The *Overbid* proxies for the willingness to pay, whereas the *Overpricing* is determined by the success of the bidding strategy as it measures the price paid by bidders benchmarked by the market rate. Our third measure is also related to the performance in the auction, *Award*, defined as the received amount to bid amount at the bank level.

2.2.2 Relationship and Network Measures

We start by borrowing measures from the relationship lending literature to identify interbank relationships. Several proxies are used in empirical work to distinguish between relationship lenders and transactional lenders. These are the duration of the relationship between the firm and the bank, various loan categories, number of creditors as well as the largest financing share[6] (see Boot (2000) and Petersen and Rajan (1994) among others; and Degryse and Ongena (2008) and Degryse, Kim and Ongena (2009) for reviews). Studies on interbank relationships consider similar measures as in Furfine (2001) and Cocco, Gomes and Martins (2009). We measure banks' concentration of borrowing using the largest share of financing (using short-term exposures, on-balance sheet and on-and-off-balance sheet exposures alternatively. We chose to report the estimation results using the latter, *MaxShare_all*, as our findings are mainly similar). We compute the share as the largest amount borrowed by bank *j* in quarter *t* relative to the overall amount borrowed by bank *j*. This measure gives us the information on the asymmetry in financing and the intensity of the relationship lending. We further take the four consecutive lags of the largest share to take the average on a rolling

[6] Elsas (2005) finds evidence of a strong connection between the share of financing and the probability of (self-assessing) being the relationship lender.

window. This approach enables us to claim a causal relationship and to deal with the differences in the frequency of data.[7]

Our alternative measure for lending relationships is the number of lenders in the interbank market. *N_all* is defined as the natural log of number of lenders observed in on-and-off-balance sheet exposures, again averaged over four lags. We also estimate our model using only on-balance sheet short-term exposures, but only report the former for brevity.

We hypothesize that banks that cannot benefit from relationships in interbank lending will turn to the primary market for their liquidity needs and bid more aggressively compared to other banks. If we would observe the same mechanism as in bank-firm relationships, namely that close ties might facilitate monitoring, the degree of intensity of relationships, i.e. lower *N_all* or higher *MaxShare_all*, is expected to lead to lower bid rates.

In addition, we provide other measures of connection to the interbank network than those of simple measures of immediate links. While the measures described above indicate the degree of direct connectivity of a bank with other banks, it does not really measure the connections with the rest of the system through banking intermediaries. With our information about all of the bilateral exposures of the German interbank network, we can construct the entire network with all of its connections, both direct and indirect. With that in mind, we would expect the more connected parts of the network to carry a surcharge. The idea is that the more connected portion of the network is exposed in ways that their counterparties can not know. Because of this unknown exposure, loans made to these banks are riskier, given the same relationship lending. These banks must pay a higher price for the risk.

We gauge the connectedness of the nodes with a variety of measures. The measure reported here is the *betweeness centrality* measure. This measure is related to the notion of a *geodesic*, which is the shortest path between two banks (or nodes) in a network. The

[7] Pricing variables are measured on a weekly basis, whereas balance sheet variables are monthly and credit register consist of quarterly data.

betweeness centrality of a bank is the number of shortest paths in a network that goes through the that particular bank. A higher level of betweeness centrality means that the bank is more centrally located in the network in that it is an essential intermediary between more nodes, and in this sense is more connected to the network. Other measures of connectedness could have been reported. We report this measure because it emphasizes a measure that is quite separate to the notion of links, which we associate with information inherent in relationship lending, and it has a fairly simple interpretation in terms of intermediation exposure.

2.2.3 Control variables

We control for bank characteristics using balance sheet variables and reserve data. We include *Interbank_borrowing* defined as overall interbank borrowing to total assets, *Equity* ratio and *Size* defined as Log of total assets. To account for the liquidity position, we make use of the daily fulfillment of reserves one day before the auction, normalized by the number of days left to the end of the maintenance period.

$$fulfill_{ijp} = \frac{\left[daily\ holding_{ijp} \Big/ cumulative\ required\ reserves_{ijp} \right]}{days\ left_{jp}} \qquad (1)$$

where *fulfill* is measured for bank *i*, auction *j* and maintenance period *p*.

In addition, we control for *due*, the maturing repo amount of the previous auction divided by total assets of the bank. Finally, we include *announced*, defined as the natural logarithm of the announced amount before the auction, in order to capture the expectations of the participants.

3 Results

We explore the impact of interbank relationships on the bidding behavior, pricing and performance variables respectively. Table 2 reports the fixed effects panel estimation results explaining *Overbid*.[8] The first, fourth and seventh specifications include the entire time period from 1999 to 2007. In the first three specifications, we investigate the impact on the largest share of financing as the relationship measure; in the second set, we employ the number of lenders. The results are not in line with the relationship lending literature. Having a more concentrated borrowing structure or a lower number of lenders leads to a higher bid rate on average. This finding suggests that banks may prefer to diversify the liquidity risk of their lenders in the interbank market by avoiding concentration. Although monitoring intensity is expected to be higher with a lower number of lenders, hence closer ties between lenders and borrowers, the borrower bank bids much more aggressively in an ECB auction due to higher fixed costs. The betweenness centrality measure is negatively related to the bidding variable; however, the magnitude is close to zero.

Higher interbank borrowing reduces the willingness to pay as expected. Capitalized and larger banks, on the other hand, can afford to pay higher rates, hence bid for higher rates too. The higher the maturing repo amount, the more aggressive the bank would bid in an auction. Moreover, when short in liquidity to fulfil their reserve requirements, banks with fewer interbank lenders place significantly higher bids in the auctions than banks with a higher number of interbank lenders.

Table 3 presents the results explaining *Overpricing* defined as weighted average rate paid minus the swap rate. The coefficient for the largest share in interbank borrowing is in line with the previous finding suggesting that banks end up paying higher interest rates when they rely on concentrated borrowing. While this result supports the diversification argument, the

[8] We also estimate our model using a pooled panel. The results are unaffected.

next result is puzzling since banks with a higher number of lenders pay higher rates as well. We observe the same with the betweenness measure. Concerning the control variables, we also find it difficult to explain the reversing sign of the coefficient for the balance sheet variables moving from the first to second specifications. There may be two reasons for this inconsistency. First, we introduce two new variables in the second, fifth and eighth specifications, daily fulfilment of reserves and the announced amount to be allotted before the auction. It is plausible to assume that the results in previous columns were driven by the lack of these variables measuring the real liquidity position of banks and the overall expectations of the auction participants. Second, the change might be due to time differences as the latter columns cover a more recent time period from 2004 to 2007.

We observe the same pattern for the performance variable, *Award* (see Table 4). This is not surprising as both *Overpricing* and *Award* are determined by a successful bidding strategy and the auction outcome; hence they are closely linked. In other words, while these measures also reflect the bidding behaviour, they are the equilibrium values and are affected by several factors including the ECB's policy and other participants' bidding strategies that are endogeneous. Thus, we believe that Overbid is a better and cleaner measure to identify the aggressiveness of the bidders related to their liquidity needs.

3.1 Decision to Participate

So far, our methodology did not consider a bank's decision to participate in an auction or not. However, it is very likely that this decision is not random and may be determined by certain bank characteristics including banking groups. Therefore, we would like to correct for a potential selection bias by estimating a Heckman (1979) selection model. Table 5 presents our findings for the bidding behaviour.[9]

[9] We also estimate the model for pricing and performance variables. The results are virtually unchanged and available upon request.

In the first stage, we estimate a *probit* model for the decision of participating in an auction. In the second stage, i.e. the selected sample, we explain the bidding behaviour by including the inverse Mills ratio obtained from the first stage to correct for any selection bias.

We find that interbank relationships do not have a major influence on the decision to participate. However, we find some evidence that having a higher number of interbank lenders increases the probability to participate in an auction. This supports the classical arguments of relationship lending literature where the number is inversely related to the degree of relationship intensity as well as availability of credit. However, in the second stage, motives to diversify liquidity risk play a role instead, that we have already observed before.

Larger banks with a higher interbank borrowing and cooperative banks are more likely to participate in auctions. Liquidity needs also play a role, not different than the influence on the bidding behaviour. The signs and statistical significance for most of the parameters in the second stage remain almost unchanged compared to previous section.

4 Conclusion

During the financial crisis, several developments affected institutional structures in the interbank market. The increase in counterparty risks lead to a substantial rise in secured interbank lending relative to uncollateralized interbank loans. The ECB decided to reduce the channel, i.e. the interest rate difference between the two standing facilities. While these developments presumably reduced the risk of domino effects in the banking sector, their overall welfare implications are far from being fully understood. For instance, it is still unclear to what extent these developments weaken market discipline in the interbank market.

In this paper, we try to contribute to a more profound understanding of these issues. In particular, we study to what extent peer monitoring or more precisely relationship lending

prevails in the German interbank market. To our knowledge, only a few papers investigated relationship lending in the interbank market so far. Cocco, Gomes and Martins (2009), for instance, find that relationships affect banks' ability to borrow in the interbank market.

We find that banks that have a higher number of bank relationships in the interbank market are more likely to participate in an ECB auction. However once participated in the auction, having a more diversified borrowing leads to lower bid rates. This suggests that while the decision of participating in an auction is driven by the degree of interbank relationships, bidding behavior is determined by the diversification of bank liquidity risk. We also find that having a more concentrated borrowing structure increases the willingness to pay.

References

Afonso, G., A. Kovner, and A. Schoar, 2011, Relationships Matter: The Importance of Relationships in the Fed Funds Market, mimeo.

Basel Committee on Banking Supervision, 2011, Global Systemically Important Banks: Assessment Methodology and the Additional Loss Absorbency Requirement, Consultative Document, Bank of International Settlements, Basel.

Bech, M., and E. Atalay, 2010, The Topology of the Federal Funds Market, *Physica A: Statistical Mechanics and its Applications* 389, no. 22, 5223-46.

Boot, A. W. A., 2000, Relationship banking: What do we know? *Journal of Financial Intermediation* 9(1), 7-25.

Braeuning, F., 2011, Relationship Lending and Peer Monitoring: Evidence From Interbank Payment Data, Tinbergen Institute, Mimeo.

Carletti, E., 2004, The Structure of Bank Relationships, Endogenous Monitoring, and Loan Rates, *Journal of Financial Intermediation* 13, 58-86.

Carletti, E., V. Cerasi, and S. Daltung, 2007, Multiple-Bank Lending: Diversification and Free-Riding in Monitoring, *Journal of Financial Intermediation* 16(3), 425-451.

Cocco, J. F., F. J. Gomes and N. C. Martins, 2009, Lending Relationships in the Interbank Market, *Journal of Financial Intermediation* 18, 24–48.

Craig, B. R., and F. Fecht, 2007, The Eurosystem Money Market Auctions: A Banking Perspective, *Journal of Banking and Finance*, 31, 2925–2944.

Craig, B. R., and G. von Peter, 2010, Interbank Tiering and Money Center Banks, Federal Reserve Bank of Cleveland working paper, no. 1014.

Degryse, H., Kim, M., Ongena, S., 2009, *Microeconometrics of Banking: Methods, Applications and Results*, Oxford University Press, Oxford

Degryse, H., Ongena, S., 2008. Competition and regulation in the banking sector: a review of the empirical evidence on the sources of bank rents. In: Thakor, A., Boot, A. (Eds.), *Handbook of Financial Intermediation and Banking*. Elsevier, pp. 483–554.

Detragiache, E., P. G. Garella, and L. Guiso, 2000, Multiple versus Single Banking Relationships: Theory and Evidence, *Journal of Finance* 55, 1133-1161.

Elsas, R., 2005, Empirical Determinants of Relationship Lending, *Journal of Financial Intermediation* 14, 32-57.

Fecht, F., K. G. Nyborg, and J. Rocholl, 2011, The Price of Liquidity: Bank Characteristics and Market Conditions, *Journal of Financial Economics* 102, 344–362.

Furfine, C. H., 2001, Banks As Monitors Of Other Banks: Evidence From The Overnight Federal Funds Market, *Journal of Business*, 74, 33-57.

Furfine, C. H., 2003, Interbank Exposures: Quantifying the Risk of Contagion, *Journal of Money, Credit, and Banking* 35(1), 111-128.

Heckman, J. J., 1979, Sample Selection Bias as a Specification Error, *Econometrica,* 47(1), 153-61.

Holmstrom, B. R., and J. Tirole., 1997, Financial Intermediation, Loanable Funds and the Real Sector, *Quarterly Journal of Economics*, 112, 663–91.

Linzert, T., D. Nautz, and U. Bindseil, 2007, Bidding Behaviour in the Longer Term Refinancing Operations of the European Central Bank: Evidence from a Panel Sample Selection Model, *Journal of Banking and Finance*, 31, 1521-1543.

Linzert, T., Nautz, D., Breitung, J., 2006, Bidder Behavior in Central Bank Repo Auctions: Evidence from the Bundesbank, *Journal of International Financial Markets, Institutions and Money* 16, 215–230.

Nyborg, K. G., U. Bindseil, and I. A. Strebulaev, 2002, Bidding and Performance in Repo Auctions: Evidence from ECB Open Market Operations, European Central Bank, Working Paper 157.

Ongena, S., G. Tümer-Alkan and N. von Westernhagen, 2011, Creditor Concentration: An Empirical Investigation, Working Paper.

Petersen, M., and R. Rajan, 1994, The Benefits of Lending Relationships: Evidence from Small Business Data, *Journal of Finance* 49, S. 3-37.

Rochet, J.-C. and J. Tirole, 1996, Interbank Lending and Systemic Risk, *Journal of Money, Credit and Banking* 28(4), 733-762.

Upper, C., and A. Worms, 2004, Estimating Bilateral Exposures in the German Interbank Market: Is There a Danger of Contagion?, *European Economic Review* 48(4), 827-849.

Table 1 Summary Statistics

		Obs	Mean	Std. Dev.	p25	p50	p75
Auction data	**Definition**						
Number of bidders	Number of bidders	102,115	393.057	120.194	325.00	358.00	419.00
overbid	weighted bid rate minus swap rate	101,432	0.012	0.099	-0.03	-0.01	0.02
overpricing	weighted paid rate minus swap rate	101,432	-0.380	1.214	-0.03	-0.01	0.01
due	due amount to Total Assets	90,448	0.300	0.630	0.04	0.16	0.35
announced	Log announced amount before the auction	54,481	12.400	0.311	12.25	12.54	12.61
Relationship variables							
All banks							
N_interbank	log number of lenders-for short term loans	55,628	0.814	0.982	0.000	0.693	1.099
N_all	log number of lenders	59,812	1.546	1.263	0.693	1.386	2.169
MaxShare_all	largest share in on-and off BS loans	59,812	0.690	0.240	0.529	0.714	0.888
MaxShare	largest share in on BS loans	59,812	0.686	0.243	0.524	0.710	0.887
MaxShare_ST	largest share in short term loans	59,812	0.791	0.249	0.672	0.879	1.000
Bidder banks							
N_interbank	log number of lenders-for short term loans	10,785	1.627	1.470	0.693	1.253	2.015
N_all	log number of lenders	10,946	2.745	1.591	1.749	2.420	3.277
MaxShare_all	largest share in on-and off BS loans	10,942	0.552	0.248	0.375	0.574	0.747
MaxShare	largest share in on BS loans	10,785	0.664	0.276	0.464	0.703	0.912
MaxShare_ST	largest share in short term loans	10,930	0.543	0.252	0.359	0.562	0.741
Reserve data							
Deficit	reserves to be fulfilled before the auction (mln Euros)	51,018	1140.000	4830.000	42.10	174.00	535.00
Balance Sheet variables							
All banks							
Interbank_borrowing	Interbank borrowing to Total Assets	274,467	1.293	124.058	0.098	0.149	0.226
Equity	Equity ratio	274,467	-1.076	128.279	0.041	0.049	0.059
Total Assets	Total Assets (mln Euros)	274,468	3864.823	24600.000	113.1199	316.4145	1010.091
Bidder banks							
Interbank_borrowing	Interbank borrowing to Total Assets	26,086	0.232	0.133	0.141	0.204	0.292
Equity	Equity ratio	26,086	0.046	0.021	0.038	0.045	0.052
Total Assets	Total Assets (mln Euros)	26,086	13300	42500.000	649.3294	1541.354	3859.786

Table 2 Bidding Behaviour

The table reports the fixed effects panel estimation results. The dependent variable is *Overbid*, defined as weighted bid rate minus swap rate. All variable definitions are presented in Table 1. Robust standard errors are in parentheses. ***,**, * significant at 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RL variables									
MaxShare_all	0.038***	0.060***	0.060***						
	[0.003]	[0.005]	[0.005]						
N_all				-0.028***	-0.052***	-0.052***			
				[0.001]	[0.002]	[0.002]			
between							-0.000**	-0.000***	-0.000***
							[0.000]	[0.000]	[0.000]
BS variables									
Interbank_borrowing	-0.056***	-0.105***	-0.105***	-0.036***	-0.069***	-0.069***	-0.071***	-0.139***	-0.139***
	[0.005]	[0.008]	[0.008]	[0.006]	[0.008]	[0.008]	[0.006]	[0.009]	[0.009]
Equity	0.478***	0.730***	0.730***	0.459***	0.771***	0.771***	0.533***	0.746***	0.746***
	[0.027]	[0.029]	[0.029]	[0.026]	[0.029]	[0.029]	[0.031]	[0.031]	[0.031]
Size	0.049***	0.127***	0.127***	0.056***	0.137***	0.137***	0.052***	0.137***	0.137***
	[0.002]	[0.003]	[0.003]	[0.002]	[0.003]	[0.003]	[0.002]	[0.004]	[0.004]
liquidity needs									
due	0.006***	0.010***	0.010***	0.003***	0.007***	0.007***	0.006***	0.010***	0.010***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
fulfill		-0.054***	-0.049***		-0.054***	-0.088***		-0.074***	-0.071***
		[0.009]	[0.017]		[0.009]	[0.018]		[0.009]	[0.016]
fulfill * RL			-0.013			0.008**			-0.001
			[0.035]			[0.004]			[0.002]
auction variables									
announced		-0.126***	-0.126***		-0.126***	-0.126***		-0.126***	-0.126***
		[0.002]	[0.002]		[0.002]	[0.002]		[0.002]	[0.002]
Constant	-0.755***	-0.330***	-0.330***	-0.753***	-0.304***	-0.303***	-0.764***	-0.423***	-0.423***
	[0.025]	[0.050]	[0.050]	[0.026]	[0.048]	[0.048]	[0.027]	[0.054]	[0.054]
Observations	82,701	39,218	39,218	82,701	39,218	39,218	79,021	38,009	38,009
R-squared	0.025	0.305	0.305	0.03	0.318	0.318	0.023	0.305	0.305
Number of banks	799	538	538	799	538	538	764	519	519

Table 3 Overpricing

The table reports the fixed effects panel estimation results. The dependent variable is *Overpricing*, defined as weighted paid rate minus swap rate. All variable definitions are presented in Table 1. Robust standard errors are in parentheses. ***,**, * significant at 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RL variables									
MaxShare_all	0.349***	0.339***	0.333***						
	[0.058]	[0.093]	[0.093]						
N_all				-0.04	0.387***	0.390***			
				[0.025]	[0.041]	[0.041]			
between							0.013***	0.004*	0.005**
							[0.002]	[0.002]	[0.002]
BS variables									
Interbank_borrowing	-0.307***	1.310***	1.309***	-0.332***	0.987***	0.988***	-0.270**	1.643***	1.643***
	[0.112]	[0.168]	[0.168]	[0.113]	[0.170]	[0.170]	[0.119]	[0.180]	[0.180]
Equity	1.815***	-6.778***	-6.774***	1.719***	-7.730***	-7.743***	2.151***	-7.432***	-7.422***
	[0.563]	[0.648]	[0.648]	[0.562]	[0.641]	[0.640]	[0.584]	[0.663]	[0.663]
Size	0.304***	-1.075***	-1.075***	0.324***	-1.138***	-1.137***	0.257***	-1.104***	-1.104***
	[0.031]	[0.068]	[0.068]	[0.031]	[0.067]	[0.067]	[0.031]	[0.071]	[0.071]
liquidity needs									
due	0.538***	0.377***	0.377***	0.538***	0.401***	0.400***	0.508***	0.335***	0.335***
	[0.016]	[0.022]	[0.022]	[0.016]	[0.023]	[0.023]	[0.015]	[0.022]	[0.022]
fulfill		-0.435	-0.686		-0.453*	0.57		-0.495**	0.031
		[0.279]	[0.521]		[0.271]	[0.462]		[0.235]	[0.317]
fulfill * RL			0.662			-0.234**			-0.085*
			[0.869]			[0.105]			[0.047]
auction variables									
announced		1.287***	1.286***		1.272***	1.273***		1.301***	1.301***
		[0.044]	[0.044]		[0.043]	[0.043]		[0.044]	[0.044]
Constant	-5.104***	-0.796	-0.793	-5.067***	-0.514	-0.538	-4.273***	-0.494	-0.501
	[0.458]	[0.964]	[0.964]	[0.458]	[0.947]	[0.947]	[0.464]	[1.001]	[1.001]
Observations	82,701	39,218	39,218	82,701	39,218	39,218	79,021	38,009	38,009
R-squared	0.019	0.133	0.133	0.019	0.136	0.136	0.018	0.137	0.137
Number of banks	799	538	538	799	538	538	764	519	519

Table 4 Measuring Success of Bidding

The table reports the fixed effects panel estimation results. The dependent variable is *Award*, defined as the received amount to bid amount. All variable definitions are presented in Table 1. Robust standard errors are in parentheses. ***,**, * significant at 1%, 5% and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
RL variables									
MaxShare_all	0.065***	0.018	0.02						
	[0.015]	[0.027]	[0.027]						
N_all				-0.052***	0.084***	0.084***			
				[0.007]	[0.012]	[0.012]			
between							0.007***	0.001	0.001
							[0.001]	[0.001]	[0.001]
BS variables									
Interbank_borrow	-0.056*	0.386***	0.386***	-0.017	0.319***	0.319***	0.002	0.499***	0.499***
	[0.029]	[0.047]	[0.047]	[0.030]	[0.047]	[0.047]	[0.031]	[0.050]	[0.050]
Equity	0.838***	-1.732***	-1.733***	0.803***	-1.892***	-1.892***	0.976***	-1.790***	-1.790***
	[0.156]	[0.181]	[0.180]	[0.155]	[0.177]	[0.177]	[0.163]	[0.183]	[0.183]
Size	0.128***	-0.132***	-0.132***	0.140***	-0.147***	-0.147***	0.115***	-0.127***	-0.127***
	[0.008]	[0.020]	[0.020]	[0.008]	[0.020]	[0.020]	[0.008]	[0.021]	[0.021]
liquidity needs									
due	0.234***	0.188***	0.188***	0.228***	0.192***	0.192***	0.217***	0.169***	0.169***
	[0.005]	[0.007]	[0.007]	[0.005]	[0.007]	[0.007]	[0.005]	[0.007]	[0.007]
fulfill		-0.342***	-0.266		-0.345***	-0.344		-0.532***	-0.551***
		[0.100]	[0.174]		[0.099]	[0.221]		[0.076]	[0.107]
fulfill * RL			-0.199			0			0.003
			[0.277]			[0.039]			[0.014]
auction variables									
announced		0.401***	0.401***		0.399***	0.399***		0.410***	0.410***
		[0.010]	[0.010]		[0.010]	[0.010]		[0.010]	[0.010]
Constant	-1.222***	-2.323***	-2.324***	-1.219***	-2.298***	-2.298***	-1.030***	-2.520***	-2.520***
	[0.118]	[0.300]	[0.300]	[0.119]	[0.296]	[0.296]	[0.122]	[0.312]	[0.312]
Observations	83,366	39,827	39,827	83,366	39,827	39,827	79,648	38,594	38,594
R-squared	0.045	0.136	0.136	0.045	0.137	0.137	0.044	0.139	0.139
Number of banks	799	538	538	799	538	538	764	519	519

Table 5 Selection Model

The table reports the two-stage estimation results using the Heckman (1979) selection model; the first, fourth and seventh columns report the first-stage probit results for the probability participating in an auction, the remainder of the columns reports fixed-effects panel estimations explaining Overbid. All variable definitions are presented in Table 1. Robust standard errors are in parentheses. ***,**, * significant at 1%, 5% and 10%, respectively.

	(1)	(2)	*(3)*	(4)	(5)	*(6)*	(7)	*(8)*	(9)	(10)	*(11)*	(12)	(13)
	Participate	Overbid	*Participate*	Overbid	Overbid	*Participate*	Overbid	*Participate*	Overbid	Overbid	*Participate*	Overbid	Overbid
RL variables													
MaxShare_all	*-0.100*	0.038***	*0.054*	0.060***	0.060***								
	[0.104]	[0.003]	*[0.125]*	[0.005]	[0.005]								
N_all						*0.070***	-0.028***	*0.046*	-0.052***	-0.052***			
						[0.034]	[0.001]	*[0.042]*	[0.002]	[0.002]			
between											*0.001*	-0.000***	-0.000***
											[0.006]	[0.000]	[0.000]
BS variables													
Interbank_borrowing	*1.099****	-0.056***	*0.632****	-0.105***	-0.105***	*1.025****	-0.036***	*0.567****	-0.069***	-0.069***	*0.789****	-0.138***	-0.138***
	[0.174]	[0.005]	*[0.206]*	[0.008]	[0.008]	*[0.178]*	[0.006]	*[0.209]*	[0.008]	[0.008]	*[0.245]*	[0.009]	[0.009]
Equity	*-4.397****	0.478***	*-1.917*	0.714***	0.714***	*-4.170****	0.459***	*-1.757*	0.756***	0.756***	*-1.376*	0.731***	0.731***
	[1.239]	[0.027]	*[1.330]*	[0.029]	[0.029]	*[1.202]*	[0.026]	*[1.266]*	[0.029]	[0.029]	*[1.291]*	[0.031]	[0.031]
Size	*0.171****	0.049***	*0.203****	0.127***	0.127***	*0.128****	0.056***	*0.163****	0.138***	0.138***	*0.198****	0.138***	0.138***
	[0.019]	[0.002]	*[0.023]*	[0.003]	[0.003]	*[0.029]*	[0.002]	*[0.035]*	[0.003]	[0.003]	*[0.022]*	[0.004]	[0.004]
banking groups													
regional banks	*-0.005*		*-0.036*			*-0.025*		*-0.067*			*-0.072*		
	[0.094]		*[0.138]*			*[0.093]*		*[0.135]*			*[0.142]*		
savings banks	*0.024*		*-0.147****			*0.038*		*-0.136****			*-0.169****		
	[0.026]		*[0.038]*			*[0.025]*		*[0.037]*			*[0.037]*		
cooperative banks	*0.090****		*-0.001*			*0.087****		*-0.001*			*-0.010*		
	[0.027]		*[0.040]*			*[0.026]*		*[0.039]*			*[0.040]*		
liquidity needs													
due	*9.095****	0.006***	*11.180****	0.014***	0.014***	*9.105****	0.003**	*11.188****	0.011***	0.011***	*11.157****	0.014***	0.014***
	[0.207]	[0.001]	*[0.271]*	[0.002]	[0.002]	*[0.206]*	[0.001]	*[0.272]*	[0.002]	[0.002]	*[0.275]*	[0.001]	[0.001]
fulfill			*-1.901****	-0.056***	-0.053***			*-1.949****	-0.056***	-0.087***	*-3.648****	-0.076***	-0.072***
			[0.585]	[0.009]	[0.016]			*[0.580]*	[0.009]	[0.018]	*[0.476]*	[0.009]	[0.016]
fulfill * RL					-0.008					0.007**			-0.001
					[0.035]					[0.004]			[0.002]
auction variables													
announced			*-0.332****	-0.126***	-0.126***			*-0.336****	-0.126***	-0.126***	*-0.335****	-0.126***	-0.126***
			[0.043]	[0.002]	[0.002]			*[0.043]*	[0.002]	[0.002]	*[0.042]*	[0.002]	[0.002]
Mills		0.000		0.003***	0.003***		0.000		0.002***	0.002***		0.002***	0.002***
		[0.001]		[0.001]	[0.001]		[0.001]		[0.001]	[0.001]		[0.001]	[0.001]
Constant	*-3.497****	-0.755***	*-0.073*	-0.336***	-0.336***	*-3.123****	-0.753***	*0.460*	-0.309***	-0.308***	*0.036*	-0.430***	-0.430***
	[0.317]	[0.026]	*[0.684]*	[0.050]	[0.050]	*[0.358]*	[0.026]	*[0.708]*	[0.048]	[0.048]	*[0.630]*	[0.054]	[0.054]
Observations	*324,670*	82,701	*150,375*	39,218	39,218	*324,670*	82,701	*150,375*	39,218	39,218	*146,786*	38,009	38,009
R-squared		0.025		0.305	0.305		0.03		0.318	0.318		0.305	0.305
Number of banks		799		538	538		799		538	538		519	519