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This paper analyzes the individual bidding behavior of German banks in the money market auctions conducted by the ECB from the beginning of the third quarter of 2000 to the end of the first quarter of 2001. Our approach takes a variety of characteristics of the individual banks into account. In particular, we consider variables that capture the different use of liquidity and the different attitude towards liquidity risk of the individual banks. It turns out that these characteristics are reflected in the banks' respective bidding behavior to a large extent. Thus our study contributes to a deeper understanding of the way liquidity is managed in the banking sector.

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1 Introduction

A significant question for central banks is the equity and efficiency of the design of liquidity provision. The European Central Bank injects liquidity into its banking system through a mechanism that differs from the US system, where the Federal Reserve Bank repurchases Treasury bills in open market operations with a small number of large counterparties. In the European Monetary Union, the primary means for controlling the amount of liquidity is through money market auctions, held once a week, in which any bank can bid for collateralized liquidity with a two week maturity. Does the European system operate to the advantage of one set of banks over another? If so, is this a set of banks one would want to support through the liquidity system? Initial study of this issue provided somewhat perplexing answers. Studies (such as Nyborg, Bindseil, and Strebulaev (2002)) with crude size data on banks indicated that larger banks participated more in the liquidity auctions, suggesting, perhaps, that information about the auction might be concentrated more in these banks, giving them an advantage. This contrasts with the design policy of the auctions, which was intended to provide an equal footing to all participating banks, large and small.

The answer to the question of equity and efficiency depends crucially on how the various banks use liquidity. Auction liquidity is of a very particular form that may fit the needs of one group of banks over another, regardless of the information structure associated with the conduct of the auction. Simply observing whether a large group of banks participates more in an auction is not sufficient to provide answers to the questions of either equity or efficiency. One has to observe the auction in the context of a wide set of bank characteristics and in the context of alternative markets for liquidity, each with their own set of risk characteristics and prices. The very particular form of the auction liquidity provided by the ECB must also be examined within this context of competing markets for liquidity and the particular needs of different types of banks.

In this paper we analyze a unique data set that we have collected. It matches the individual bidding behavior of German banks in the money market auctions with such bank characteristics as charter type, asset size, and the extent of the bank's activity in the interbank market, an alternative liquidity to that provided by the auction. We can observe the auction behavior of individual banks in order to characterize different banks' risk and their expected costs of running out of liquidity. The data set includes auctions conducted by the ECB from the beginning of the third quarter of 2000 to the end of the first quarter of 2001. We analyze the bidding behavior of the different types of banks in the context of their liquidity needs, especially for the very specific form of liquidity offered by the ECB auctions, in an environment of competing liquidity sources.

Liquidity from the ECB is provided as a collateralized loan or repurchase agreement with a two-week maturity. Banks know well in advance of an auction the minimum bid rate, below which the ECB will not accept any bids. The banks submit a schedule of rates and the amounts of liquidity they are willing to purchase at each rate.The ECB reports the aggregate amount of liquidity it intends to inject into the system before the close of the auction. At the close of the auction the ECB calculates the marginal lending rate. Each bid above the marginal lending rate wins the liquidity at the rate that was bid. Bids at the marginal lending rate are awarded liquidity on a prorated basis of the amount bid at that rate.

Within the week between any two such "repo" auctions, the ECB in general does not influence the liquidity available to the banking system. Thus interest rates in the interbank market may fluctuate, sometimes significantly. Two standing facilities, the Marginal Lending Facility and the Deposit Facility, supplement the main refinancing operations. The Marginal Lending Facility sets an interest rate at which banks can borrow unlimited amounts of liquidity against collateral. At the Deposit Facility, banks can deposit excess liquidity with the ECB at a fixed marginal deposit rate. These rates provide upper and lower bounds that limit the fluctuations of the interbank overnight rate (the so-called "EONIA rate").

In general, when banks decide their bidding strategy in the money market auctions, they balance the interest they have to pay if they win a bid in the auction against the expected costs they face if they run out of liquidity and have to draw on the secondary or interbank market.[1] The costs that individual banks face when borrowing in the interbank market may vary significantly. Since the money market is still mainly uncollateralized, rates also reflect the individual credit default risk. Thus, small banks, which have a higher default probability on average, can be expected to pay higher rates. However, in Germany, particularly small savings banks are usually provided with liquidity from their respective head institutes (the so-called Landesbanks). Moreover, because of the government guarantees for savings

[1]As Nyborg, Bindseil, and Strebulaev (2002) show in their study, the interest rate in the interbank market is on average higher than the marginal rate at which liquidity is allotted in the money market auctions. They interpret that as a sign of underpricing following the winner's curse problem. But, as we show, this may also simply reflect an endogenous market segmentation.

banks, even small savings banks do not have to pay much of a risk premium in the interbank market. Thus their cost when borrowing in the interbank market might be lower than those faced by commercial banks and credit cooperatives of a similar size. Consequently, their bidding behavior might be less aggressive. Moreover, the probability of a liquidity need may vary significantly between banks. For example, big banks can net out large fractions of custumers' payments internally (because they have many customers on both sides of the settlement), whereas at small banks most payments are external and thus require liquid funds.

More importantly, banks involved in different facets of the banking business may exploit economies of scope in their liquidity needs. A bank that is engaged in only one line of business faces a smaller likelihood of a need for liquidity than a bank active in many fields of business. (This is true as long as the liquidity needs are not perfectly negatively correlated across businesses.)[2] For example, most banks provide lines of credit that must be met with very liquid assets. Just holding liquid reserves against the risk that the customer will draw on these credit lines might not be optimal. A bank may plan to borrow in the interbank market to provide the required liquidity when the need arises. In contrast, a bank that offers lines of credit and is at the same time also engaged in providing payment system services to other smaller banks faces a higher probability of a liquidity need. For such a bank, a large liquidity buffer might be efficient. Thus large banks, which offer a multitude of liquidity-intense services, are more likely to demand liquidity while smaller, more specialized banks may be more dependent on borrowing in the interbank market. Smaller banks also cannot take advantage of the natural economies of scale inherent in netting out opposing liquidity needs.

In contrast to the Fed, the ECB imposes much more restrictive minimum reserve requirements. In the United States, working balances that banks hold in order to clear payments, buffer liquidity outflows, and so forth, exceed the required reserve holdings, whereas in the euro area, liquidity held by each bank is generally determined by the reserve requirement.[3] However, these more restrictive reserve requirements in the Euro area need only be fulfilled as a monthly average.

If minimum reserve requirements are the binding constraint on a bank, should we really observe the effects of economies of scope or institutional structure in the bidding behavior for liquidity? Clearly, taking minimum reserve requirements into account makes these suggestions more subtle. If minimum reserve requirements ex-

[2]See Kashyap, Rajan, and Stein (2002) for a similar argument.

[3]See Bindeseil, Weller, and Wuertz (2003) for a broader discussion of that point.

ceed working balances, the different liquidity needs will be reflected in the bank's differing bidding behavior in each of the four auctions taking place during a single maintenance period. Banks with varied uses for liquidity should have a continuing demand for liquidity over the entire maintenance period. They will therefore continually bid for liquidity in the money market auctions. In contrast, banks with a rather limited use for liquidity should try to acquire liquidity cheaply in the first auctions of a maintenance period by placing bids in the money market auction that are just slightly above the minimum bid rate. By doing this, these banks can gamble on fulfilling their reserve requirements cheaply. If they fail to win auction liquidity, then they can demand liquidity in the interbank market from those banks with a wider spectrum of business activities, which win liquidity in the auction by placing higher bids but turn out ex-post to need less liquidity.

The literature that analyzes the framework of the ECB and particularly the bidding behavior of the banks in the auctions has largely been concerned only with the mechanical question of how to improve the operational framework from the perspective of monetary policy implementation. However, these studies do not take any individual bank's characteristics into account that could reveal more about the structure of the liquidity demand of the banking sector. For example, a recent study by Linzert, Nautz, and Breitung (2003), which analyzes the bidding behavior of Hessian banks, only takes two very rough bank characteristics into account. In fact, maturing allotments—the liquidity obtained in the repo auction 14 days earlier—are the only real bank-specific variable in this study. Even the size of the bank is captured by a crudely defined dummy variable, which divides the sample of banks into two groups based on the type of charter the bank has (which is only broadly correlated with size). Nyborg, Bindseil, and Strebulaev (2002) study bidding behavior of all banks participating during the first year of the ECB's variable-interest-rate-tender auctions (starting in June 2000) from an auction-theory perspective. They are particularly interested in the question of whether bigger banks have a competitive advantage in the money auctions. They find that indeed bigger banks consistently borrow at lower rates in the repo auctions than smaller banks just by using more bids dispersed at different values within the same range as the smaller banks, and with more different bids at the extremes of the range.

In contrast to these previous studies, our paper takes a much broader set of individual bank characteristics into account. We do so because it is our general perception that in addition to fulfilling minimum reserve requirements, the driving force behind the demand for liquidity at each individual bank is the actual opportunity cost of holding the liquidity. This opportunity cost varies a great deal among different banks, as they have different uses for liquidity. Our study is motivated by findings such as Furfine (2000)'s for US banks. He shows that with higher transaction volume in the payment system, banks have a higher risk of not meeting the reserve requirement and therefore have a higher precautionary demand for liquidity. Liquidity use is sensitive to the nature of the business that the particular bank is conducting.

In our study, the larger banks use the auction liquidity more because they have a steady liquidity need. They are driven by their inability to substitute lower-price liquidity intertemporally. Thus, spending resources to make the auction process more transparent may not have the effect of making the smaller banks more competitive. Moreover, according to our results, favoring smaller banks at the expense of bigger institutions in the auctions would clearly be inefficient. This would not only bring about an inefficient liquidity allocation but also an inefficient distribution of liquidity risk.

In sum, these intuitions have implications that are testable by matching the available data on bidding behavior in the money market auctions with data on individual bank characteristics, and in particular, their activity in the secondary market. Net lenders in the market should bid more often and win more in auctions, particularly at the beginning of a maintenance period. Net borrowers or smaller banks, who are less able to take advantage of economies of scale and scope, are less likely to bid and should bid less. Thus, levels of activity in the auctions should be higher for larger banks, payments banks, and banks with lots of action in the secondary market as lenders.[4]

The rest of the paper starts with a description of the data we have assembled to study the auctions. We then describe some simple reduced-form results from the data. The following section describes our empirical procedures for the more complex estimations. The results of our various procedures are fairly robust and consistent with each other, so that we are fairly confident in our conclusions.

2 Data

Our data consists of the bids submitted by all German banks that participated in the thirty-nine liquidity auctions conducted by the European Central Bank from June

[4]compare the intuition with results in Nyborg, Bindseil, and Strebulaev (2002) with respect of uncertainty and reduced underpricing at the end of a maintenance periode

28, 2001, to March 21, 2002, and measures that describe various characteristics of all individual banks, both bidders and non-bidders. We matched the proprietary data of all bids submitted to ECB to balance sheet data collected by the Bundesbank. This was a period of some interest rate volatility, so that we can observe the behavior of different banks as they hedged against the interest rate risk. The variables that we use can be ordered into three sets: first a set of variables that describe all the the individual banks in Germany; second, a set of variables that describe the environment of risk that characterizes a particular auction; and, finally, the variables that describe the individual bank's bidding behavior and its outcome for a particular auction.

The variables *PublicBanks* and *Commercial* describe what a bank does, at least in terms of its formal charter, and do not vary over the data period. *PublicBanks* is a dummy for chartered Landesbanks and savings banks, whose primary purpose is to provide regionwide financial services as opposed to concentrating these services only in major metropolitan areas. They are intended to serve a regional public interest rather than primarily to maximize profits. However, they rely on retained profits to grow. Smaller savings banks obtain liquidity from the Landesbanks and not through the formal interbank market. We expect the smaller savings banks to be less involved and bid less aggressively in the auctions than other banks of the same size. (We refer to these banks as "public" throughout the paper.) In contrast, *Commercial* is a dummy for the commercial banks. Besides the four big German commercial banks, this mainly covers the regional commercial banks, branches of foreign banks, and the Postbank, which is especially involved in payment system operations. This banking group is certainly the most profit or shareholder value oriented banking group. However, banks within that group differ to a large extent with respect to the degree of specialization and business areas that they are involved. Consequently, this group should follow most likely the patters described in the introduction. For instance, we would expect that particularly small commercial banks that are borrowers in the interbank market will vary their bidding behavior during the maintenance period. The credit cooperatives are the control group. Credit cooperatives make up most of the institutions in Germany. They are less focused on short-term profit maximization than the commercial banks. In the cooperative banking sector, smaller institutions often obtain liquidity outside the interbank market, from one of two banks, the WGZ Bank or the DZ Bank. However, this network is less close than that between the Landesbanks and the savings banks.[5]

[5]See Upper and Worms (2002) for a more detailed discussion of these issues.

Coefficients on the dummy variables, *Commercial* and *Public*, are interpreted as differences between these two types of banks and the credit cooperatives.

Other bank characteristics did vary over the sample period, in particular, *logassets*, the log of total assets of the bank, and *reserve*, the log of the minimum reserve requirement during the settlement period of the auction. These variables measure the general size of the bank and its automatic involvement in the liquidity market. It should be noted that the assets variable is taken from monthly balance sheet data and reflects only the situation of the bank at the most recent end-of-month date before the auction takes place.

Two variables that take into account the activity of the bank in the secondary overnight market are more problematic in that end-of-month bank balance sheet data do not measure a total flow of funds into and out of the overnight market. Instead, what is available is a snapshot of the banks' activity on the last business day of the month. Clearly this is a noisy proxy for bank liquidity activity in the overnight market. We average the activity in the overnight market over the six months preceding the auction for both borrowing and lending activity in the overnight funds market. Thus, *Loans* is the six-month average of lending in the secondary market, divided by the bank's reserve requirement, and *Borrowings* is the ratio of borrowing in the secondary market to reserve requirement over the same period.

The second set of variables describes the risk environment faced by the banks in each auction. These do not vary by bank, but they do vary over time. We measure the reaction of banks with differing characteristics by interacting the risk environment variables with the individual bank variables described above. We tried many variables that measured the risk environment facing the banks. The following variables measured the concepts that best reflect the risk and liquidity trade-offs that banks consider when deciding whether to bid in the liquidity market or to obtain necessary liquidity by other means:*Maintenance end*, *Garch Eonia*, *Swap*, *Repo spread*, and *Forward spread*. Clearly the risk of not fulfilling the reserve requirements is particularly high for some banks at the end of the maintenance period. Thus *Maintenance end* is a dummy that is set to one for the last auction in the maintenance period.

Other risk-environment variables were obtained from financial time series. When banks decide to whether to use the auction market or its chief competitor, the overnight short-term liquidity market (the Eonia overnight market), the decision is based on interest-rate risks, default risks, and so forth. These considerations represent partial equilibrium factors as opposed to the general equilibrium factors that are of great importance to the monetary authority. These partial equilibrium concerns center around the differences between the two markets.

The auction market differs from the Eonia market along several dimensions of risk, each of which we try to measure by variables taken from the financial markets. First, the auction liquidity is bid at a rate that gives a certain amount of liquidity at a fixed rate. However, whether one really wins the bid is not known in advance. Thus auction liquidity is associated with an "auction risk." In contrast, liquidity provision through the interbank market is associated with interest rate risk, given that the Eonia market rate varies from day to day. We measure this risk with a simple volatility measure, *Garch Eonia*, which is computed from daily Eonia data from 1999 onward with a simple Garch(1,1) estimated equation. If the interest rate risk associated with liquidity through the overnight market is high, bidding for liquidity in the money market auctions should be preferred.

However, using a two-week Eonia swap, a bank can hedge this interest rate risk. The Eonia swap is a contract that exchanges a payment based on the fixed swap rate at the end of two weeks (which we capture with *Swap*) for one based on the arithmetic average of the daily Eonia rates during the same period. Thus the Eonia swap rate is the risk-free rate at which a bank could receive liquidity for two weeks without incurring the auction risk.

In addition, the Eonia market differs from the auction market in that loans are, for the most part, unsecured. Thus there may be default risk associated with this market. We measure this risk with the variable *Repo spread*, which is the spread between the swap rate for the unsecured Eonia market and the rate for the secured repo market, where short-term liquidity is purchased with securities for two weeks, which are then repurchased at the end of the period. Thus, once the variable rate risk is held constant with *Swap* variable, the *Repo spread* controls for the default risk implicit in the Eonia rate.

To measure the risk-adjusted expected change in interest rates over the short run as perceived by the markets, we include the variable, *Forward spread*, the spread between the current Eonia rate and the one-week forward rate. This measures the expected gains from holding liquidity now to fulfill the reserve requirements, instead of demanding liquidity in the next auction in one week.

Broad correlations between the five measures of risk are shown in table 1. With the exception of *Forward spread*, the measures during this period were generally uncorrelated with one another. The five principal components that can be distilled from these five risk measures each add something. The smallest factor still accounts for about 8 percent of the variation. So while not completely orthogonal measures, these measured risk factors still represent separate phenomena in the risk environment facing the banks during this time period. However, it is not so much the impact of the different risk measures itself on the bidding behavior of banks that we think is most interesting, it is more the interaction of these variables with individual bank characteristics.

Our dependent variables concern the bidding behavior of the banks. They can be divided into two broad classes: those that capture whether and how the bank bid, and those that capture the outcome of the bid. The first class contains three variables that summarize the bidding: One captures whether the bank bid in the auction, one captures the average bid for a participating bank, and one summarizes the complexity of a bank's bid behavior, specifically, the number of different price bids that it submitted. The second class of dependent variables includes whether the bank won any liquidity, the quantity of liquidity won, and the quantity-weighted price of the liquidity won. These variables are summarized in table 2 in the appendix.

Several patterns are clear from table 2. First, bidders are more likely to be larger banks (in terms of total assets) than the population of all German banking institutions as a whole. They are also much more likely to be *Commercial* or *PublicBanks*. Indeed, the *PublicBanks* make up more than half of the bidders in the sample, although they represent only a tenth of the total banks in the system. Banks that borrow in the overnight market are also more likely to bid and to win, while those that lend in the same market bid and win less often. This is consistent with a naive view that there are lenders and borrowers in the short-term liquidity market. Borrowers go to both the overnight and the auction markets, while lenders avoid the auction market because they are already flush with liquidity. This view is too naive, as we will document later in this paper. The margin requirement is also positively associated with the activity in the auction market.

3 The simple regression results

Measuring the effect of bank characteristics on bidding behavior is complicated by the fact that the amount bid is only measured for those banks who bid, and the amount won in a bid is measured only for those banks who win. Thus, for example, if we want to see the elasticity of the amount of liquidity won in an auction with respect to bank size, and how this is influenced by the swap rate, we need an unbiased estimate of the corresponding coefficient. Simply regressing the logarithm of the amount won on observed variables that include the logarithm of bank size does not give an unbiased estimate of the relevant coefficient because the only banks included in the regression are those that won some amount. However, banks that bid in our auctions may not be representative of banks as a whole. More importantly, differences between banks that win liquidity and banks in the general population may not be easily measured with observable variables and may indeed be correlated with the error term in a regression analysis, which makes the measurement less convincing in an argument about bank behavior. In other words, we have a classic selection problem, where we know only the bidding strategy of those banks that actually bid. To compensate for this problem, all of our reported results have a Heckman (1976) correction included in the estimating equations, where the standard errors of the estimate are also corrected for the censoring problem. We find that all of our censoring terms are very significant, and that correcting for sample selection matters significantly for our results.

In addition, the panel nature of our data set was accounted for, though not in a strict fixed-effect method. Many of our variables did not change over the period of the data set, in particular the *Commercial* and *PublicBank* dummies. The *Loans* and *Borrowings* variables also represented weighted averages over a long time period, because these variables were "snap shots" taken at the end of each month, used to measure a stock of behavior. A strict fixed-effect estimation technique is not appropriate in equations that contain this variable. As a result, the standard errors for the estimates reported in this paper reflect a correction for the random-effects estimation procedure used, as well as a correction for the heteroskedasticity induced by the first-stage estimation.[6]

The main results of our basic regressions are summarized in table 3. Each column represents a separate regression of bid behavior. The first column describes the results from the probit on the likelihood of participation in an auction. The coefficients in the second column detail the effect on the amount bid in an auction, given that a bank participated in the auction. The third column reports coefficients of a probit on whether the bank won liquidity in an auction, and the fourth column reports the coefficients on the amount won, given that some liquidity was won by the bank. The fifth column presents the quantity-weighted price paid for the liquidity won by a bank, given that some liquidity was won. The t-values for the respective estimates are given in brackets.

[6] Other error schemes in which a fixed effect may be correlated with variables such as log assets are investigated in a second paper.

The main results concerning the effect of the price and risk measures on the bidding behavior of the banks in our sample are intuitively rather convincing. If the price for 14-day liquidity in the interbank market (measured by *Swap*) is high and therefore the expected marginal bid price is high, the participation as well as the total amounts bid and won are low. Instead of demanding two-week liquidity, banks will try to obtain the liquidity needed by drawing on the overnight market or by substituting the fulfillment of the minimum reserve requirement intertemporally.

Interestingly, an increase in *Swap* causes almost an equal increase in the weighted price at which banks receive liquidity in the money market. This is consistent with the view that the swap rate is a good predictor of the marginal rate outcome at the end of the auction. However, the coefficient of *Swap* is slightly but significantly larger than one. This suggests that the auction risk, measured as the discount of the weighted price paid for liquidity received in the auctions over the swap rate, is higher during phases of lower money market rates. This may reflect the gambling of smaller banks in the auctions at the beginning of the maintenance period, when liquidity is comparably cheap. These banks bid more aggressively in times of serious liquidity need, for instance at the end of the month (when derivative contracts are often settled), and when money market rates are typically high.

Although the *Repo spread* has no significant effect on the probability of participation or the amount bid, it is strongly correlated with the weighted price paid for liquidity in the money market auction. Thus an increase in the mark-up for uncollateralized interbank loans goes along with a higher weighted price paid for liquidity in the auctions, as banks substitute out of the uncollateralized market.

A higher volatility of the overnight rate has a positive effect on the probability of participation in money market auctions and increases the total amount bid. This is basically in line with the intuition that a higher interest rate risk makes banks less willing to bear the risk of having to turn to the overnight market to obtain additional liquidity. The average price at which banks receive liquidity in the auctions is negatively affected by a higher volatility in the overnight rate, which is reflected in an increase in *Garch Eonia*. This is consistent with the view that the monetary authority makes liquidity available at a lower price in times of higher interest rate volatility.

The negative effect of an expected price increase on participation and bidding in the auctions, which is reflected in a rise in *Swap*, is largely compensated for if market participants expect a further interest rate hike at the next auction. This is shown in the strong and significant coefficient of *Forward spread*. However, an expected interest rate increase at the next auction has a small but significantly negative effect on the weighted average price of liquidity in this auction, which is counterintuitive.

All these price and risk measures obviously do not fully reflect the usually tighter liquidity situation at the end of the maintenance period. The results show an independent, positive end-of-maintenance-period effect on participation and on the weighted price at which participating banks won liquidity in the auctions. However, the amounts bid and the amounts won are on average lower at the end of the maintenance period. This may reflect the fact that the participating banks only try to provide the liquidity they really need for themselves — particularly for the fulfilment of their own minimum reserve requirements — instead of bidding to offer larger parts of the liquidity in the interbank market.

Similar to previous studies, our results also provide evidence that larger banks have a higher participation rate and tend to bid and win more in the ECB auctions than smaller banks.[7] They may use more sophisticated bidding strategies, as pointed out in Nyborg, Bindseil, and Strebulaev (2002), which may explain why they nevertheless manage to pay less for the liquidity won.

Our results rather robustly point out that banks that have excess liquidity, which they use to grant loans in the interbank market, are less likely to participate in the auctions. In contrast, banks that are collecting liquidity in the interbank market have a higher participation rate in the auctions. However, given that they bid, banks that are active in the interbank market, whether on the borrowing or on the lending side, tend in general to place larger bids and win larger amounts in the money market auctions. This larger involvement in the interbank market in general might therefore also explain why larger borrowing as well as lending in the interbank market reduces the weighted price these banks pay in the auctions.

There are important differences in the bidding behavior of the three German banking system sectors. Our results show that commercial banks are far more likely to bid in auctions than the control group — credit cooperatives. In contrast, the likelihood of public banks participating is substantially lower.[8] While in general the participation of larger banks is more likely, this size effect is more distinct for commercial banks than for credit cooperatives and especially for the public sector. The size of a public bank is less important for determining the total amount bid

[7]See for instance, Nyborg, Bindseil, and Strebulaev (2002) and Linzert, Nautz, and Breitung (2003).

[8]The public banks make up a larger fraction of the bidding banks than their numbers in the population would suggest. However, this is because of the other measured characteristics of the public banks, which have positive effects on the probability of bidding.

than for commercial banks or credit cooperatives. The size of the bank does not have a significant effect for the amounts that public banks win, while size increases this amount for commercial banks and reduces it for credit cooperatives. Public and commercial banks do not significantly differ in the weighted price that they pay at auction. On average, they both pay a lower price than credit cooperatives. However, larger commercial and public banks pay a higher price than credit cooperatives of the same size.

Altogether these results show that the structure of the German banking system is strongly reflected in the bidding behavior of the banks in the money market auctions. The particularly close relationship between the Landesbanks and the savings banks in the public bank sector brings about a specialization in liquidity provision within this group of strongly associated banks. Only a comparatively small fraction of public banks consisting mostly of the larger ones (particularly the Landesbanks) participates in the money market auctions. However, once public banks participate, they tend to place higher bids and win larger amounts than any other banking group. Presumably they pass this liquidity, to some extent, on to smaller savings banks. In addition, they also provide the liquidity-intensive services for these smaller banks. In sum, this enables the public banks to obtain liquidity through the auction more efficiently than the credit cooperatives and at an average price similar to the commercial banks. However, given that a bank participates in the auction, the price it pays on average is higher the larger the bank. This is especially true for public and commercial banks. Correcting for the censoring problem, our results, particularly for commercial and public banks, provide an answer which stands in sharp contrast to Nyborg, Bindseil, and Strebulaev (2002), who report a lower average price paid by larger banks. Our result is consistent with the view that smaller banks are simply taking advantage of their intertemporal substitution opportunities and speculating in the auction to win low-cost liquidity.

4 The interaction of risk measures and individual banks' characteristics

A main interest of our study lies in the interaction of the characteristics of the individual banks with the different risk measures and their combined effect on the bidding behavior in the money market auction. The way different banks adjust their bidding strategies in the money market auctions to changes in the different risk measures over time reveals much about the styles of risk management and risk allocation among different types of banks in the German banking system.

Two approaches are used to measure the joint effect of bank characteristics and risk measures on bidding behavior. In one approach we first run a separate set of probit equations and censored regressions for each of the weekly auctions. The coefficients of the individual bank characteristics from these regressions are themselves then regressed on a set of time series variables — namely the time series of the risk measures. Thus, the coefficients from the regressions and probits are, themselves, treated as time series variables. The advantage of this first strategy is that it is fairly useful with large data sets as an exploratory device. Breaking up the estimation allows one to quickly estimate separate coefficients, using only data from that auction, and to assemble them later in a second step. Many possible time series patterns in the data are easily seen in the second step, because we can subject our results to classical specification tests, just as we would for any classical time series variable. In the regressions of coefficients on the interest rate variables, the Durbin-Watson statistics, for example, were generally within the 5% bounds, so that estimating our panel using time series effects seems to be unwarranted.

But while this first approach has an advantage in exploration of the data, it has the disadvantage of not using the variance structure to its fullest extent to create estimates with smaller standard errors. So we also use a second approach and treat our sample more classically, running a censored regression model on the full sample at once. The interaction of bank characteristics and risk environment effects are measured by the coefficients on cross effects in classical probits and censored regressions. As in the work above, we correct the standard errors to handle the effects of cross covariances of the error term within the same auction and of heteroskadasticity due to the estimated Heckman correction in the first stage. After our specification is decided, we run our well-specified model on all of the data to achieve smaller standard errors.

Another advantage of the first (two-step) approach is an increased ease in seeing the influence of specific auctions on the data. If, for example, there is an unusual auction in terms of who bid on or who won liquidity, then a quick graph of the time series of the coefficients will point it out. It is this procedure that showed us the necessity of tossing out the auction of September 27, 2000. Coefficients estimated from this auction were many orders of magnitude different from all other auctions, and represented large outliers for every coefficient. This certainly represented the very different liquidity environment created by the massive foreign currency intervention that the ECB, Federal Reserve, and Bank of England conducted on the date of the auction. We exclude this auction.

Table 4 reports the estimates of the regressions of coefficients on the risk environment variables. The first row represents the coefficients and standard errors of the regression of the separate *Borrower* coefficients (where each observation is a separate coefficient obtained from a single auction) on the risk environment variables. Each row represents a separate regression, each of which has 37 observations, one for each auction. The coefficient reported for *Swap* in the *Borrower* row, *Amount Bid*, thus reports the effect of an increase in the swap rate on the responsiveness of *Borrower*s to bid more in auctions.

Apparently, the different groups of banks react most characteristicly to changes in *Swap*. The swap rate represents the price of a close substitute for auction liquidity (and as noted earlier is the best predictor of the auction's marginal rate), although it does not include the auction risk. Thus, when the swap rate goes up, those banks that do not have a continuous need for liquidity should drop out of the market, as they try to intertemporarily substitute the fulfilment of their minimum reserve requirement. Compared to other banks, the amount bid by banks that cannot intertemporarily substitute goes up. These banks are the large banks with various businesses. Similarly, banks that tend to be lenders in the interbank market increasingly demand larger amounts in the auction. Those are the banks that have—because of their particular business strategies—a high demand for liquidity. If they have excess liquidity, they supply it to the market.

However, those banks that can intertemporarily substitute seem to speculate in the auctions trying to raise liquidity at a low price. Borrowers in the interbank market are supposedly banks that do not have a continuous liquidity need and therefore fulfill their occasional liquidity needs by demanding liquidity from other banks in the interbank market. By placing bids at particluarly low prices in the auctions, they can, however, speculate on winning cheap liquidity. This is why their probability of bidding increases with a higher *Swap*, while the amount bid and won does not change. In contrast, the probability of lenders and larger banks bidding goes down. This might reflect the fact that these banks—because of their continuous liquidity needs—are less willing to incur the auction risk (which supposedly increases in periods of higher interest rates).[9]

[9]ALTERNATIVE VIEW: Oddly, when the swap rates are lower, the number of lenders in the money market bidding in an auction goes up. However, the amount bid actually goes down. This is consistent with bank lending in the money market having two components: banks who are taking advantage of the opportunities to balance their lending portfolios, and (often smaller) banks that lend when they have excess cash. These banks, which are in the funds markets almost

In addition, smaller savings banks and credit cooperatives seem to draw more heavily on their respective internal liquidity suppliers, either the WGZ or the DZ bank, in times of high interest rates. Consequently, the liquidity demand of (smaller) commercial banks in the auctions increases relative to these savings banks and credit cooperatives. Admittedly, this explanation strikes us as perhaps the most puzzling of our exposition, in that we would have thought the smaller commercial banks would substitute intertemporally when the swap rate is high.

The *Garch* measurement represents interest risk in the Eonia market, as seen in its volatility. This measure seems to be associated with the behavior of the larger banks. When the volatility is high, bigger banks intensify their participation in the money market auctions. In particular, larger banks may not be able to hedge their entire short-term interest rate risk in the interbank market using swaps. Receiving liquidity at a fixed rate for 14 days might be particularly appealing for these banks if interest rate volatility is high.

In addition, small commercial banks seem to react to an increase in *Garch*. The higher *Garch* is, the more likely smaller commercial banks are to win in a liquidity auction. Incidentally, for many of the risk measures, it is the smaller commercial banks that are more likely to win something in a liquidity auction. In this regard, the larger commercial banks behave more like large banks. Another way of putting it is that the large banks, whether commercial or otherwise, are likely to win *something* in nearly every auction, so that whether they win is not dependent on the risk environment. However, increasing the interest rate risk, or the risk of default, or the risk of running short of reserve requirements at the end of the maintenance period all make it more probable that the smaller commercial banks (as opposed to the smaller banks) will win something in a liquidity auction.

However, an increase in the repo spread that measures the default risk not only brings the smaller commercial banks into the liquidity auctions (so that they bid to win), it also brings the public banks as well. This is rather puzzling. Given government guarantees for public banks, the rates those banks have to pay in the interbank market should be least affected by an increasing default risk spread. Interestingly, the default risk also causes the larger commercial banks to win more liquidity, but at a smaller price in terms of the auction risk.

The risk approximated by the futures spread is rather subtle and has to do with the timing of the fulfilment of the minimum reserve requirement. It measures

"accidentally," make up more of the auction market than the careful liquidity portfolio managers, when the swap market is an attractive substitute for the auction market.

the gain from fulfilling the minimum reserve requirement currently, as opposed to after the following ECB auction. Thus, banks that hold liquidity only to fulfill the minimum reserve requirement can try to substitute the liquidity intertemporally in order to fulfill the requirement. As the estimates show, the small commercial banks in particular behave in this way. If an increase in *Spread* signals an increase in the money market rates after the next auction, they are more likely to participate in the auction, and they are even more willing to pay an excess price. However, the amounts they win are negatively affected by an increase in the forward spread. Those banks that win a significantly larger amount in times of higher forward spreads are the public banks. Here it might be the fact that small savings banks often need liquidity to fulfill their minimum reserve requirement more than the small commercial banks do. In contrast, the large commercial banks cannot substitute their liquidity holdings intertemporally within one month. They have a large, continuous need for liquidity for their everyday business. They do not gain from increasing their liquidity demand in the money market auction if an interest rate increase is expected after the next auction. Consequently, as our data show, they are even less likely to bid if the forward spread indicates an expected interest rate increase.

The end of the maintenance period bears the risk of not meeting the reserve requirement. This results in more lenders winning some liquidity. This is consistent with the view that lenders in the interbank market provide the liquidity (risk) management for other banks to a large extent. At the end of the maintenance period liquidity risk at those banks that only need liquidity to fulfil the reserve requirement rises. Thus money market lenders that provide the liquidity management to these banks face a higher risk that they actually have to provide liquidity to these banks. Consequently, the money market lenders have to increase their buffers so that they are not caught short when their customers need to borrow to fulfill their reserve requirement. In contrast to the small savings banks and credit cooperatives, the smaller commercial banks might not be able to fully draw on the liquidity management of other large banks. Thus they — at least partially — increase their likelihood of winning additional liquidity themselves when they run the risk of not meeting the minimum reserve requirement at the end of the maintenance period. Similarly, those banks with larger reserve requirements (ceteris paribus) are more likely to win in a liquidity auction as they reach the end of the maintenance period, and they also bid a higher price.

The coefficients of the interaction terms between individual banks' characteristics and the various risk measures estimated with the second pooled approach are presented in table 5. These coefficients are reported from regressions and probits that use our entire sample in a single estimation. The standard errors of both the probits and the tobit estimates are adjusted both for the fact that the observations within a single auction share a common factor and for the fact that the errors in the second step of the estimation are heteroskadastic.

The signs and the significance levels of the coefficients of the various interaction terms for the two-step approach are also reported in table 5. Table 5 is arranged somewhat differently than table 3, in that the columns represent the risk environment variable that is multiplied by the bank characteristic variable in the row. Each bank characteristic variable is listed for five separate estimations. For example, the row labeled *Borrower* and *Amount bid* represents coefficients in the regression on the amount bid by the bank. The coefficient in the *Garch* column is the coefficient on the cross effect of the *Borrower* variable multiplied by the *Garch* variable. Only the five estimations (two probits on *Participation* and *Winning*, and three second-step regressions on *Amount bid*, *Amount won*, and *Excess price*) are represented in this table, though we report all of the cross effects. We arrange the table this way to facilitate comparison with table 4. The estimates of table 5 differ from the time series estimates of table 4, in that they impose more structure in terms of the common error term, a factor that is shared across all observations, as well as a stability of parameters that is maintained across all periods. If our imposed specification of the estimating equations is correct, more might be said about the behavior of banks. Interestingly, the results of the large regressions reported in table 5 are sensitive to the assumptions made about the form of the error structure. We report the estimates where the contemporaneous error term is correlated across observations experiencing the same auction because they provide a more reliable indication of which estimated coefficients are significantly different from zero.[10]

A look at the coefficients of table 5 largely confirms the results of table 4. Indeed, the new results differ from the results of table 4 in only four coefficients that are significantly different from zero. Each of the four coefficients are in the cross products with the swap rate. Two of the coefficients indicate that smaller banks are less likely to bid and win liquidity when the swap rate is high. These coefficients were insignificantly different from zero in table 4 but are now statistically significant. In this case, the increased structure imposed in table 5 yields estimates that support our discussion above more strongly. The swap rate will affect the auction behavior

[10]Using the stronger assumption that each observation is uncorrelated with every other observation yields estimated coefficients that are significantly different from zero in almost every case.

of those banks that can intertemporally substitute liquidity, such as the smaller banks. These coefficients are completely in accord with this hypothesis.

Two of the cross coefficents with the swap rate reported in table 5 indicate that commercial banks are also less likely to win liquidity, although this is attenuated by size: the larger banks are more likely to behave like other large banks. These two coefficients, of all the coefficents that we report in tables 4 and 5, are the only two where the coefficients of the two tables are significantly different from zero and of opposite sign. In the scenario reported in table 5, smaller commercial banks will substitute out of the expensive auction liquidity as represented by the price of the swap for 14-day liquidity. This is more consistent with our story that smaller commercial banks deal in liquidity forms that allow them to substitute intertemporally for their liquidity needs. As such, this pair of coefficients seem to us more convincing than the ones in table 4, where a more complicated story was required. Having said that, however, what strikes an empirical researcher is the consistency of estimates across the two very different techniques. For a such a large number of cross effects, to have such a consistent story for all but two of the numbers is remarkable.

5 Conclusion

The data from the ECB auctions provides a unique opportunity to study the bidding behavior of different banks and uncover the liquidity management of different groups of banks in response to changes in the risk environment.

Our results show that the liquidity management of different groups of banks is strongly influenced by their ability to intertemporally substitute their liquidity demand. If a bank needs liquidity only to satisfy margin requirements, and the end of the maintenance period is not near, then the bank can always speculate to win liquidity in the auctions by low-balling its bids. The banks that use this strategy and reduce their bidding in the auction if the current price for liquidity is high exhibit the following characteristics in our study. They are smaller banks, borrowers in the interbank market, and are smaller commercial banks. Small public banks do not respond to the risk environment because they are, to a large extent, provided with liquidity from the Landesbanks. Other banks have continual liquidity requirements and cannot substitute intertemporally. For these banks, the 14-day liquidity offered by the money auctions is advantageous because it fixes the price of the liquidity that they will need with high probability. These banks include the larger, typically commercial banks. They also include the lenders in the interbank market because their needs arrive stochastically, and they will occasionally have excess liquidity.

Moreover, if the market expects a future increase in money market rates—as indicated by an increase in the future spread—then smaller commercial banks intertemporally adjust their bidding behavior and are therefore more likely to participate in the current money market auction and are even willing to pay an excess price. This strategy seems to provide the smaller banks and those that are borrowing in the interbank market with cheap liquidity before the end of the maintenance period, because in the last auction of a maintenance period, larger banks and those that are lenders in the interbank market bid particularly aggressively.

In addition, the bidding behavior of each bank also responds to the risk premia that the respective bank has to pay in the interbank market. Small commercial banks—those banks that supposedly have the highest default probability—bid more aggressively in the money market auctions as the spread between collateralized and uncollateralized interbank loans increases.

Obviously, the results of our study required the use of disaggregated data, which includes measurement of attributes of the bidding institutions. Our findings regarding the heterogeneity in the bidding behavior could not have been made using aggregate data. Moreover, the results of our analysis required the use of statistical techniques for analyzing data sets that had censoring in order to uncover the patterns of liquidity behavior. Use of less rich data, without accounting for censoring, can lead to misleading results. These results include some of the literature's findings of financial variables not influencing auction behavior. In contrast, our measures of the risk environment, while clearly not complete, each showed a separate aspect of liquidity risk, and each affected the bidding behavior of different sets of banks in different ways and to a different degree.

Other studies have emphasized the information structure of the auctions, which might unfairly favor larger banks at the expense of smaller ones. Our study has a different take on this. In our study, the larger banks use the auction liquidity more because they have a steady liquidity need. They are driven by their inability to substitute lower-price liquidity intertemporally. Spending resources to make the auction process more transparent may not have the effect of making the smaller banks more competitive. Moreover, according to our results, favoring smaller banks at the expense of bigger institutions in the auctions would clearly be inefficient. This would not only bring about an inefficient liquidity allocation but also an inefficient distribution of liquidity risk.

Clearly analyzing the liquidity behavior in these auctions and relating this behavior to data on bank characteristics is a fertile field, and further research in using these data promise to be fruitful. For example, a more structural model of liquidity management and allocation of liquidity risk within the banking sector should provide for a richer set of policy recommendations. Further, such structure should allow for more precise testing of the models and provide more clues to counterfactual investigation.

Appendix

Table 1: Correlations between Risk Measures

	Swap	Garch Eonia	Repo Spread	Frwd Spread	Last Maint.
Swap	1.000000	0.187132	0.119144	-0.168483	0.020116
Garch Eonia	0.187132	1.000000	-0.068635	-0.644300	0.204357
Repo Spread	0.119144	-0.068635	1.000000	-0.218478	-0.175798
Frwd Spread	-0.168483	-0.644300	-0.218478	1.000000	-0.295231
Last Maint.	0.020116	0.204357	-0.175798	-0.295231	1.000000

Table 2: Means of Variables

Variable	Full Sample	Bidders	Winners
log Assets	12.68 (1.5739)	14.262 (1.6109)	14.274 (1.5755)
Commercial	0.085847 (0.28014)	0.12116 (0.32632)	0.11199 (0.31536)
Public	0.22312 (0.41634)	0.53311 (0.4989)	0.55435 (0.49704)
Borrowing	0.27285 (2.4676)	0.40253 (1.4374)	0.37448 (1.2851)
Loans	0.53282 (3.26)	0.34603 (1.0028)	0.31636 (0.86694)
Log Margin Req.	14.962 (1.4924)	16.392 (1.3867)	16.400 (1.3665)
Amount Bid	$***$	178.09 (586.21)	183.56 (596.59)
Amount Won	$***$	$***$	117.63 (372.17)
Average Price Paid	$***$	$***$	4.6842 (0.19236)
Observations	92,444	15,145	10,313

Variables described in the text.
Estimated standard deviations in parentheses.

Table 3: Results of the simple regressions

	Probability Bid	*Amount Bid*	*Probability Won*	*LogTotal Won*	*WeightWon Price*
Constant	−4.0642 (−22.48)	−7.0119 (−33.373)	−5.7447 (−28.577)	−2.4964 (−12.134)	−0.1311 (−11.462)
Loans	−0.1568 (−19.825)	0.0107 (0.773)	−0.1815 (−17.673)	0.1476 (7.2078)	−0.0007 (−1.4692)
Borrowing	0.0109 (3.9962)	0.1604 (16.318)	0.0095 (3.1763)	0.1856 (13.629)	−0.0014 (−5.7319)
log Assets	0.3930 (36.085)	0.3805 (16.322)	0.3516 (30.126)	−0.0952 (−3.5909)	0.0036 (3.6811)
log Mrr	0.0212 (1.677)	0.2933 (17.673)	−0.0017 (−0.1218)	0.2140 (9.8739)	−0.0068 (−10.568)
Commercial	1.7201 (10.641)	0.3247 (1.8754)	1.7354 (10.17)	−1.4240 (−6.2551)	−0.0307 (−4.3369)
Public	−0.4650 (−2.9932)	0.5458 (2.5559)	0.6315 (4.3141)	0.8369 (3.6449)	−0.0308 (−4.8641)
Garcheonia	0.3225 (5.3924)	0.1020 (1.5281)	0.2786 (4.2323)	−0.2719 (−3.3296)	−0.0799 (−21.486)
RepoSpread	0.1444 (0.2867)	−0.3353 (−0.6040)	5.5143 (10.101)	−13.480 (−25.547)	1.4643 (55.2)
LastInMaintPeriod	0.0450 (3.1472)	−0.0353 (−2.2342)	0.1382 (9.0031)	−0.0317 (−1.5162)	0.0022 (2.7813)
Spread	0.2407 (4.1315)	0.1121 (1.7895)	0.3377 (5.2344)	−0.4023 (−4.9391)	−0.0639 (−18.304)
Swap	−0.5519 (−17.032)	−0.0557 (−1.295)	−0.0732 (−2.0388)	0.4196 (9.1554)	1.0373 (777.11)
logAssetsCommercial	−0.1012 (−8.6495)	−0.0017 (−0.1441)	−0.1052 (−8.6119)	0.1148 (7.2163)	0.0019 (4.0058)
logAssetsPublik	0.0684 (6.0525)	−0.0371 (−2.2769)	−0.0112 (−1.0576)	−0.0923 (−5.2265)	0.0019 (4.0515)
MillsRatio		0.8416 (9.4844)		4.4193 (35.893)	−0.0028 (−0.5326)

Table 4: Cross Effects of Variable and Risk

Borrower	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	0.0953 (3.631)	−0.0093 (−0.1936)	−0.3836 (−0.9616)	−0.6512 (−1.3754)	−0.0112 (−0.9766)
Probit-Win	0.0589 (0.0295)	0.0686 (1.2678)	0.3675 (0.8205)	−0.0063 (−0.1179)	0.0067 (0.0129)
Amount Bid	−0.0140 (−0.2045)	0.1780 (1.4167)	0.3268 (0.3140)	0.2156 (1.7455)	0.0236 (0.7904)
Amount Won	0.1098 (0.6717)	−0.1500 (−0.5004)	−2.7724 (−1.1164)	−0.1301 (−0.4412)	−0.0746 (−1.0463)
Excess Price	−0.0018 (−0.8672)	0.0009 (0.2451)	0.0194 (0.6312)	0.0004 (0.1125)	−0.0005 (−0.6075)

Lenders	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.2818 (0.0718)	−0.1461 (0.1317)	0.4681 (0.4291)	−0.0066 (−0.0514)	0.0205 (0.6548)
Probit-Win	−0.4544 (−1.517)	0.0381 (0.0693)	2.7680 (0.6082)	0.3378 (0.6254)	0.2215 (1.6949)
Amount Bid	0.1952 (2.4081)	−0.07581 (−0.5099)	1.5537 (1.2615)	−0.0533 (−0.3648)	−0.0112 (−0.3164)
Amount Won	0.4482 (1.2361)	0.2731 (0.4105)	−0.5500 (−0.0998)	0.0915 (0.1400)	−0.1047 (−0.6613)
Excess Price	−0.1348 (−0.6701)	−0.0023 (−0.0630)	0.3500 (1.1455)	0.0141 (0.3883)	0.0074 (0.8461)

log *Assets*	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.1658 (−2.9238)	0.1506 (1.4479)	−0.2776 (−0.3222)	0.0632 (0.6179)	0.0188 (0.7609)
Probit-Win	0.1017 (1.209)	0.0723 (0.4688)	0.2312 (0.1809)	−0.0099 (−0.651)	0.0027 (0.0723)
Amount Bid	0.3565 (2.9050)	−0.0514 (−0.2284)	−0.1882 (−0.8505)	−0.1882 (−0.8505)	0.0031 (0.0584)
Amount Won	0.3285 (1.5908)	0.2676 (0.7063)	3.8136 (1.2153)	0.0614 (0.1650)	0.0419 (0.4648)
Excess Price	0.0050 (0.5265)	0.0044 (0.2597)	−0.0533 (−0.3784)	−0.0085 (−0.5091)	−0.0007 (−0.1724)

Table 4 (cont.)

Commercial	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.3886 (−0.6047)	−0.4337 (−0.3679)	0.2587 (0.0265)	1.6997 (1.4666)	0.0848 (0.3025)
Probit-Win	−0.2709 (−0.3999)	1.9036 (1.5320)	34.7024 (3.3716)	1.4619 (1.1967)	0.4294 (1.4525)
Amount Bid	1.3589 (2.1093)	−0.8791 (−0.7439)	−6.8595 (−0.7007)	−1.5628 (−1.3451)	−0.1206 (−0.4291)
Amount Won	2.1058 (1.2263)	−0.7170 (−0.2276)	−45.0691 (−1.7273)	−2.7366 (−0.8837)	−0.2694 (−0.3595)
Excess Price	0.0418 (0.8797)	0.0643 (0.7373)	1.2044 (1.6666)	0.0324 (0.3783)	0.0220 (1.0608)

Commercial −assets	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	0.0453 (0.9859)	0.0287 (0.3400)	0.1125 (0.1612)	−0.1333 (−1.6085)	−0.0064 (−0.3199)
Probit-Win	0.0383 (0.7974)	−0.1313 (−1.4910)	−2.3658 (−3.245)	−0.1021 (−1.1789)	−0.0314 (−1.4977)
Amount Bid	−0.0664 (−1.5263)	0.05269 (0.6602)	0.2164 (0.3274)	0.1000 (1.2743)	0.0039 (0.2054)
Amount Won	−0.1432 (−1.1779)	0.0681 (0.3053)	3.1874 (1.7259)	0.1815 (0.8283)	0.0187 (0.3526)
Excess Price	−0.0027 (−0.8279)	−0.0035 (−0.5904)	−0.0846 (−1.7072)	−0.0021 (−0.3561)	−0.0018 (−1.2525)

Table 5: Cross Effects of Variable and Risk
Large Regression

Borrower	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	0.06579 (3.5785)	0.028401 (0.58949)	0.038901 (0.15018)	−0.021024 (−0.78086)	−0.00042792 (−0.051481)
Probit-Win	0.038859 (1.8904)	0.065174 (1.2861)	0.15533 (0.54963)	−0.027001 (−0.87964)	0.001436 (0.15985)
Amount Bid	−0.046566 (−1.1805)	0.16445 (2.172)	−0.0031108 (−0.0048318)	0.22741 (3.1262)	0.021591 (1.2614)
Amount Won	−0.091122 (−1.5721)	−0.12242 (−1.2972)	−0.1451 (−0.17039)	0.040858 (0.455)	−0.022868 (−1.0045)
Excess Price	−0.000905 (−0.70865)	−0.00003435 (−0.017255)	−0.017351 (−0.93424)	0.0010008 (0.51452)	−0.00024413 (−0.4987)

Lenders	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.1498 (−3.4418)	−0.19597 (−1.9817)	−0.077446 (−0.1074)	0.037919 (0.47805)	0.022134 (1.0898)
Probit-Win	−0.22866 (−4.1184)	−0.22152 (−1.7525)	−1.3334 (−1.4841)	−0.10313 (−0.89659)	0.036472 (1.4972)
Amount Bid	0.10039 (1.8989)	−0.057719 (−0.54077)	0.80105 (0.94047)	−0.22824 (−2.3813)	−0.019481 (−0.82639)
Amount Won	0.32211 (4.2448)	0.49356 (3.5355)	3.5395 (3.1993)	0.28021 (2.1547)	0.017346 (0.58019)
Excess Price	0.00116 (0.67342)	0.0032308 (1.0172)	0.037313 (1.4861)	0.00049464 (0.73169)	0.00063711 (0.21418)

log *Assets*	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.23743 (−3.5027)	0.19612 (1.6048)	−0.29598 (−0.29768)	−0.077712 (−0.64639)	−0.03539 (−1.2685)
Probit-Win	0.10797 (1.4979)	0.15785 (1.2097)	0.69696 (0.65816)	0.034303 (0.26459)	−0.0023636 (−0.08073)
Amount Bid	0.48863 (7.0081)	−0.2774 (−2.142)	−0.67003 (−0.62423)	−0.15629 (−1.3378)	0.0014675 (0.048034)
Amount Won	0.32642 (3.2976)	−0.24449 (−1.4003)	−2.0585 (−1.4468)	−0.11599 (−0.69462)	−0.027374 (−0.66941)
Excess Price	−0.0017114 (−0.80622)	−0.0011405 (−0.3114)	−0.023147 (−0.75666)	−0.00093902 (−0.26654)	−0.0012755 (−1.4553)

Table 5 (cont.)

Commercial	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	−0.47809	−0.58649	−0.75398	1.4145	0.094805
	(−0.525)	(−0.34962)	(−0.0548)	(0.88154)	(0.23895)
Probit-Win	−0.46745	0.99918	22.535	0.61794	0.20901
	(−0.49267)	(0.56777)	(1.5485)	(0.36093)	(0.50827)
Amount Bid	2.2164	−0.19391	4.8025	−0.85488	−0.089481
	(2.3994)	(−0.11005)	(0.33191)	(−0.50853)	(−0.21419)
Amount Won	2.6679	−1.9953	−32.599	−2.1011	−0.50953
	(2.1375)	(−0.90351)	(−1.7112)	(−0.9835)	(−0.93556)
Excess Price	0.04758	0.067397	1.0476	0.066794	0.0078765
	(1.7659)	(1.4158)	(2.5351)	(1.4518)	(0.66515)

Commercial −assets	Swap	Garch	Repo Spread	Spread	Maintenence End
Probit-Bid	0.050305	0.039692	0.15436	−0.1153	−0.0079195
	(0.7613)	(0.32787)	(0.15563)	(−0.99233)	(−0.27693)
Probit-Win	0.056349	−0.061866	−1.441	−0.036257	−0.016251
	(0.83325)	(−0.49336)	(−1.3928)	(−0.29675)	(−0.55531)
Amount Bid	−0.12583	0.0092842	−0.51001	0.061823	0.0017766
	(−1.9827)	(0.076779)	(−0.51284)	(0.53313)	(0.062022)
Amount Won	−0.17245	0.15092	2.1582	0.13347	0.033022
	(−2.0105)	(0.99499)	(1.6496)	(0.90846)	(0.88156)
Excess Price	−0.0033771	−0.0037447	−0.064016	−0.0039826	−0.00060691
	(−1.8455)	(−1.1592)	(−2.28)	(−1.2738)	(−0.75305)

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