

The Information Content of Central Bank Auctions: Evidence from the European Money Market*

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Abstract

The minimum bid rate pre-announced in the weekly main refinancing operations (MRO) is supposed to be the European Central Bank's (ECB) key interest rate for signalling the intended level of short-term interest rates. Using daily and intra-day data of overnight rates, we investigate whether the MRO auction results contain additional information relevant for the money market. Our results show that the marginal MRO rate is of particular importance for the overnight rate in the euro area. The strong reaction of Eonia swap rates to the marginal MRO rate suggests that the auction result may even affect longer-term interest rate expectations.

Keywords: Central bank auctions; Monetary policy implementation; European Central Bank; Money markets

JEL classification: E52; D44

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1 Introduction

Weekly main refinancing operations (MROs) are of overwhelming importance for the monetary policy implementation of the European Central Bank (ECB). The minimum bid rate pre-announced in MROs is supposed to be the ECB's key interest rate which signals the policy-intended level for short-term money market rates. In particular, liquidity supply in MROs should ensure that the European overnight rate (Eonia) closely follows the minimum bid rate and that its volatility remains well contained, see e.g. Ejerskov et al. (2008). Recently, however, a puzzling and unintended upward trend in the spread between the Eonia and the minimum bid rate revealed that the relation between MROs and the money market is underresearched. For example, contradicting earlier estimates of the liquidity effect, even the provision of massive excess liquidity in MROs could not bring the Eonia to its former level, see ECB (2006) and Linzert and Schmidt (2007).¹ In order to shed more light on the link between MROs and the interbank money market, this paper investigates how the Eonia responds to information revealed by MRO auction outcomes.

On the allotment day, the ECB publishes the number of bidders, total allotment and total bids together with the marginal and the average allotment rate of the MRO. All these variables may contain some information about the supply and the aggregate demand for liquidity. The money market response reveals whether the auction outcome has contained new and relevant information for the banks.

Our study can be related to two groups of papers. First, there is a growing empirical literature on the dynamics and the volatility of overnight rates. Recent examples include Bartolini and Prati (2006), Perez Quiros and Rodriguez Mendizabal (2006), Colarossi and Zaghini (2007), and Hassler and Nautz (2008). All these contributions investigate how distinguishing features of the central bank's operational framework influence the behavior of overnight rates. They do not focus on the response of the overnight rate to auction outcomes. The second group of papers explores banks' bidding behavior in central bank auctions, see e.g. Bindseil et al. (2004) and Linzert et al. (2007). Using individual bidding data, it can be shown that money market conditions significantly affect banks' bidding

¹In the U.S. the empirical relevance of the liquidity effect is still under debate, see e.g. Carpenter and Demiralp (2008) and Thornton (2007).

behavior. These papers try to explain the auction outcome but do not consider its repercussions to the money market.

The closest reference to our paper is Nautz (1997) who found a significant response of the German overnight rate to the auctions of the Bundesbank based on daily data. The current paper explores the information content of the ECB's MRO auctions using both daily and intra-day data of overnight rates. Moreover, we employ daily changes of Eonia swap rates to explore how the auctions affect market's expectations about future Eonia movements. In the following, we introduce the auction variables, discuss their expected influence on the Eonia and describe the relevant data. Section 3 presents the empirical results based on error-correction type adjustment equations of the money market rate to an auction outcome. Section 4 concludes.

2 Data, Variables, and Predictions

2.1 Main refinancing operations and the money market

Since June 2000, MROs are conducted as variable rate tenders, i.e. price-discriminatory multi-unit auction where banks are allowed to submit multiple price-quantity bids. In variable rate tenders the resulting repo rates partially depend on the bids of the banks and thus, are not under the ECB's full control.² Therefore, the ECB pre-announces a minimum bid rate (r_{MB}) that has become the ECB's key interest rate for signalling the policy-intended interest rate level. The ECB invites banks to submit bids from Monday 3:30 p.m. to Tuesday 9:30 a.m. At Tuesday 11:20 a.m., the ECB communicates via its wire service the following auction results: (i) the marginal rate (r_m) of the MRO (ii) the quantity weighted average rate (r_w) of all successful bids, (iii) the total bid amount, (iv) the number of bidders, and (v) the total allotment volume.

The response of the money market to an auction outcome should be reflected in overnight rates observed immediately after the auction results are available. Let i_b and i_a be the market rates valid *before* and *after* banks are informed about the auction outcomes.

²In June 2000, the ECB switched from fixed to variable rate tenders to stop the MRO's escalating overbidding problem, see Bindseil (2005).

The money market response to the auction is then revealed in $\Delta i = i_a - i_b$. We measure Δi in three ways. First, in line with the empirical literature, we use daily data of the Eonia, the European Over-Night Index Average published by the ECB.³ Eonia rates refer to transactions carried out before the closing of real-time gross settlement (RTGS) systems at 6.00 p.m. (CET) and are published on the same evening. Since the bulk of money market transactions are carried out after the auction result is published, the timing of MROs suggests to use Eonia rates of Monday (i_b) and Tuesday (i_a) to measure the money market reaction to an auction outcome.

If money markets react quickly to new information about the liquidity situation, the *average* overnight rate at the auction day could be only a poor approximation for i_a and similar problems may apply to i_b . Therefore, in a second specification of Δi , we use overnight rates published by Reuters at 9:30 a.m. and 11:25 a.m. for i_b and i_a , respectively. These rates are very close to the end of bid submission and the announcement of the auction outcome. However, in contrast to the Eonia, available intra-day data only refer to quotes of banks rather than actual transactions. Finally, a third approximation of Δi employs daily data of Eonia swap rates with one week maturity. In the Euro area, Eonia swap rates are the main instrument for speculating on and hedging against interest rate movements. The change of Eonia swap rates at the auction day should reflect the impact of the auction outcome on market's expectations about future Eonia rates.

2.2 The information revealed in an auction outcome

The marginal rate or stop-out rate of a MRO, r_m , depends on both, banks' bidding behavior and the ECB's allotment decision. In any case, deviations of the marginal rate from the overnight rate valid immediately before the auction, $r_m - i_b$, should imply that the overnight rate i_a adjusts accordingly. In an error-correction type adjustment equation of Δi , the coefficient of $r_m - i_b$ is expected to be positive.

The weighted average rate of a MRO, r_w , is typically only a few basis points above the marginal rate. Large MRO spreads, $r_w - r_m$, may increase the overnight rate after the

³The Eonia is based on a panel of approx. 50 banks with the highest business volume in the Euro area money market, see <http://www.euribor.org>.

auction for two reasons. First, if a large part of bids has been submitted at relatively high rates, the demand for liquidity might have been stronger than expected. Second, large MRO spreads indicate a high dispersion of bids typically induced by bidders' uncertainty about the auction's marginal rate, see e.g. Välimäki (2006).

The *cover to bid ratio*, *CBR*, of a MRO is defined as the ratio between the ECB's total allotment and the banks' total bid volume. Large cover to bid ratios indicate that banks received a lot of refinancing relative to their bid. One might expect that overnight rates should always decrease with increasing cover to bid ratios. However, as Linzert et al. (2007) already emphasized, a low cover to bid ratio only leads to money market tensions if it resulted from banks' misperceptions of the marginal rate and the situation in the money market. If banks bid seriously and the marginal rate of the MRO simply exceeded banks' willingness to pay, a low cover to bid ratio will not necessarily lead to increasing overnight rates. Thus, the sign of the cover to bid ratio in a money market rate adjustment equation is not obvious.⁴

The *number of bidders* in MROs has significantly declined since June 2000. Following e.g. Bindseil et al. (2004), we estimated the new information contained in the number of bidders, i.e. the unexpected part in this variable, employing a univariate forecast equation.⁵ In case of a surprisingly large number of bidders, probably indicating an unexpectedly high liquidity demand, the overnight rate should increase.

Closely related to the conduct of MROs is the volume of *actual minus forecasted autonomous factors*, *AF*, typically announced by the ECB at the auction day. Since June 2000, the ECB uses *AF* to rationalize its current allotment decision which could have deviated from market's expectations based on forecasted autonomous factors. If positive

⁴Moreover, on several occasions banks anticipated future rate cuts of the ECB and, therefore, simply refrained from bidding. As a result, banks' total bid volume was so low that the ECB could not allot the intended volume of reserves. Due to banks' underbidding, the cover to bid ratio peaked to one but due to the lack of reserves overnight rates increased sharply at the auction day. The underbidding episodes refer to the MROs on 13 Feb, 10 Apr, 9 Oct and 6 Nov 2001, 3 Dec and 17 Dec 2002, 3 Mar, 3 Jun and 25 Nov 2003, 20 Feb and 23 Mar 2004, see Bindseil (2005). We excluded these observations from the sample to ensure that our results are not driven by underbidding auctions.

⁵Forecasts are presented in the Appendix. Note that the use of alternative forecast and de-trending methods do not affect our results.

values of AF indicate an excess supply of liquidity, then the coefficient of AF in the interest rate adjustment equation should be negative.

At the end of the reserve maintenance period, when no further MRO will be conducted, liquidity shortages or excess reserves can lead to dramatic increases of overnight rate volatility. It is well understood by the market that these seasonal interest rate fluctuations are temporary and unrelated to monetary policy signals, see e.g. Nautz and Offermanns (2008). To ensure that our results will not depend on the seasonal Eonia movements at the very last day of the reserve period, we excluded the auctions performed at those particular days from the regressions. Note, however, that all our results are robust with respect to these sample adjustments. The remaining sample contains 262 auctions conducted from June 27th 2000 to August 2nd 2006. Since intra-day data is only available as of Dec 2000, the intra-day regressions are based on 232 observations.

3 The Money Market Response to an Auction Outcome

Our empirical results on the information content of the ECB's MRO auctions are based on the following error-correction type adjustment equation for the overnight rate,

$$\Delta i_t = c + \alpha(r_m - i_b)_t + \beta(r_w - r_m)_t + \gamma_C CBR_t + \gamma_B B_t + \gamma_A AF_t + \gamma \Delta r_{MB,t} + \varepsilon_t(1)$$

where for each auction t , $\Delta i_t = i_{a,t} - i_{b,t}$ denotes the change of the money market rate. α and β determine the information content of the marginal (r_m) and the weighted average repo rate (r_w). CBR and B denote the auction's logged cover to bid ratio and the unexpected part in the number of bidders, AF controls for news concerning autonomous factors. To allow for a partial adjustment of the overnight rate to pre-announced changes of the minimum bid rate, we also included Δr_{MB} in the regressions.

Table 1 summarizes our results obtained for the three measures of Δi_t . For Eonia swap rates, the only relevant information revealed by MROs is contained in the marginal MRO rate. The estimated adjustment coefficient ($\hat{\alpha} = 0.9175$) is highly significant, plausibly signed and close to one. On an auction day, the announcement of the new marginal MRO rate accounts for about 86% of the variance of swap rate movements. In contrast, none of the other auction variables published by the ECB affect the money market's expectations

Table 1: The Money Market Response to an Auction Outcome

Auction Variables	Money Market Response (Δi_t)		
	Daily Eonia	Intra Day Data	1-Week Eonia Swap Rates
$(r_m - i_b)$	0.4636*** [0.1386]	0.3455*** [0.1164]	0.9175*** [0.0540]
$(r_w - r_m)$	0.7436* [0.4422]	0.1671 [0.2179]	0.0261 [0.2585]
Cover-to-Bid Ratio (CBR)	0.0342*** [0.0133]	-0.0099 [0.0081]	-0.0039 [0.0111]
Number of Bidders (B)	0.0002 [0.0002]	-0.0001 [0.0001]	0.0001 [0.0001]
Autonomous Factors (AF)	-0.0011 [0.0013]	-0.0016** [0.0007]	-0.0006 [0.0005]
Δr_{MB}	-0.0006 [0.0710]	0.0382 [0.0688]	0.0302 [0.0201]
Obs.	262	238	262
R^2	0.50	0.53	0.86
Wald tests of parameter equality: $H_0 : \alpha = \beta$ vs $H_1 : \alpha \neq \beta$			
p-value	0.51	0.46	0.00

Notes: Estimation results refer to the money market rate adjustment equation (1). ***, **, * indicate significance at the 1%, 5%, 10% level. White heteroskedasticity-consistent standard errors in parentheses. The sample period covers Jun 2000-Aug 2006 for daily Eonia and Eonia swap rates and Dec 2000-Aug 2006 for intra day data. The index t denotes the number of the MRO. For the sake of robustness, we excluded end of period auctions, underbidding episodes and the MRO with anomalous allotment one week after the terrorist attack, i.e. 18.09.2001. Results of Wald tests presented as p-values.

about future overnight rates in a significant way. The significant role of the marginal rate is confirmed by the results obtained for daily and intra-day overnight rates. For these rates, however, the weighted average MRO rate might play an additional role. The estimated coefficients of the MRO spread ($r_w - r_m$) are plausibly signed and in case of the daily Eonia even weakly significant. The large standard errors of the estimates of β may reflect that the variation in MRO spreads is typically small. In fact, according to the Wald tests shown at the bottom of Table 1, the null-hypothesis that the information content of the marginal and the weighted average MRO rate is the same ($\alpha = \beta$) cannot be rejected for the daily Eonia and intra-day overnight rates.⁶

⁶Note that $\alpha = \beta$ implies $\alpha(r_m - i_b) + \alpha(r_w - r_m) = \alpha(r_w - i_b)$, see Equation (1).

While the announced number of bidders is clearly irrelevant for the money market, the evidence is more mixed for the cover-to-bid ratio. Whereas the estimated impact of CBR is plausibly signed but insignificant for swap rates and intra-day data, the daily Eonia responds significantly to the logged cover-to-bid ratio but with an implausible sign. The results obtained for the money market response to news about autonomous factors are also interesting. In line with the notion of a liquidity effect of an excess supply of reserves, the estimated coefficients of AF are negative for all interest rates. However, the liquidity effect of AF is only significant for intra-day data indicating that an injection of additional 10bln euros will lower the overnight by only 1.6 basis points. Given former estimates of the liquidity effect in the Euro area, the response of the money market to the liquidity provided by the ECB is remarkably weak.

4 Concluding Remarks

The minimum bid rate pre-announced in the main refinancing operations (MRO) is supposed to be the ECB's key interest rate for signalling the intended level of short-term interest rates. This paper investigated whether the auction results published by the ECB contain additional information relevant for the money market. We found that the marginal MRO rate is of particular importance for the overnight rate in the euro area. In contrast to other auction variables, including the number of bidders and the cover-to-bid ratio, the impact of the marginal MRO rate on the overnight rate is highly significant and plausibly signed. In particular, the strong reaction of Eonia swap rates to the marginal MRO rate suggests that the auction result may even affect longer-term interest rate expectations.

The significant reaction of money market rates to MRO auction outcomes might indicate that banks are to some degree uncertain about the ECB's actual policy rate and, thus, about the intended interest rate level. In fact, compared with the unambiguous target for the federal funds rate of the U.S. federal reserve, the relation between the ECB's policy rate and the target level of the overnight rate is not obvious, see e.g. Ho (2008, p.7). On the one hand, due to different maturities and collateral requirements, the "natural spread" between the minimum bid rate and the overnight rate is uncertain and may even vary over time, see Linzert and Schmidt (2007). On the other hand, there is an inherent asymme-

try in the ECB's policy rate because a minimum bid rate may be particularly effective for signalling lower bounds for the overnight rate whereas upper bounds are less clear.

Even though the ECB has downplayed the information content of its auctions on several occasions (see e.g. ECB 2002), many banks tend to believe that their results convey important policy signals. In particular, following Würtz (2003), banks apparently consider the marginal rate, and not the minimum bid rate, as the current "fair price" for liquidity, due to its better capacity as the average price paid for central bank liquidity. Moreover, in contrast to the Bank of England, the ECB seems to undermine the role of its own policy rate by referring to marginal MRO rates and not to the minimum bid rate as the remuneration rate of banks' reserve accounts.

An efficient operational framework of monetary policy should avoid uncertainty about the central bank's policy signals. The Bank of England, for example, recently emphasized that all short-term repos will be at the central bank's policy rate "to rule out speculation about whether the result of a tender revealed anything about the MPCs rate intentions", see Tucker (2004). The significant response of European money market rates to the marginal rate of the central bank's auctions suggests that the ECB may improve the implementation of its key policy rate and the communication of the intended interest rate level.

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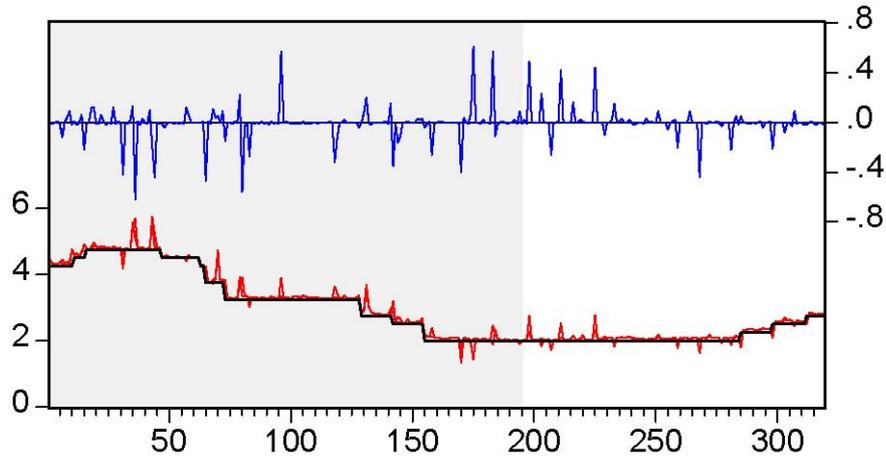
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A Appendix

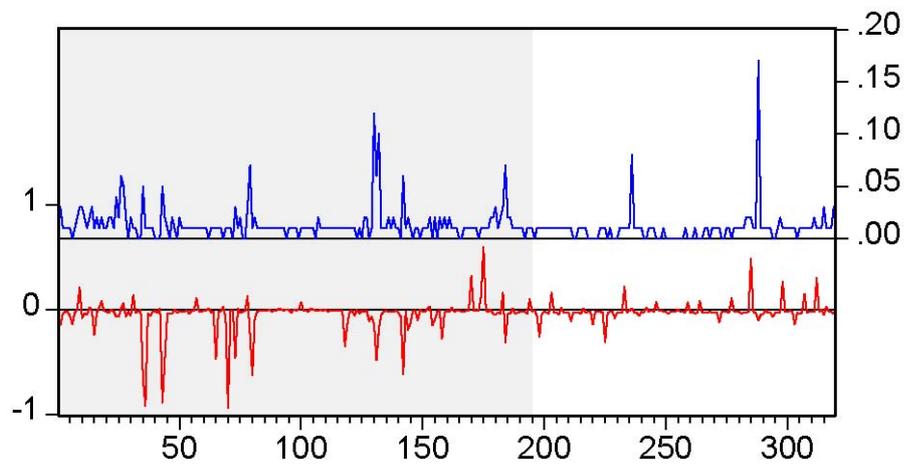
A.1 Data figures

Figure 1: Eonia and the minimum bid rate



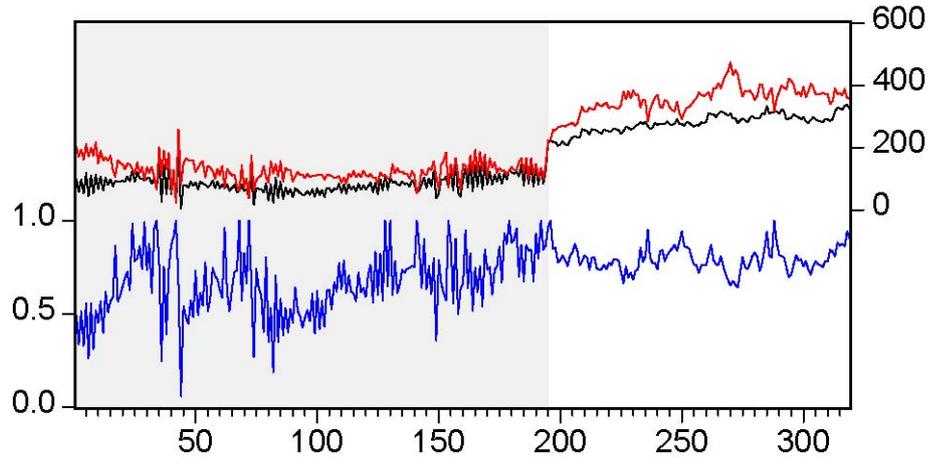
Notes: The day-to-day change of Eonia (right scale), the minimum bid rate and the Eonia on the auction day (left scale). Notice that, since the daily dataset has been pared down to the auction relevant days, the drawn data has *not* a daily frequency. The x-axis, therefore, refers only to the data at the auction t . The shaded area refers to the period prior to the reform in the ECB's operational framework as of March 2004.

Figure 2: MR spread and MRO spread



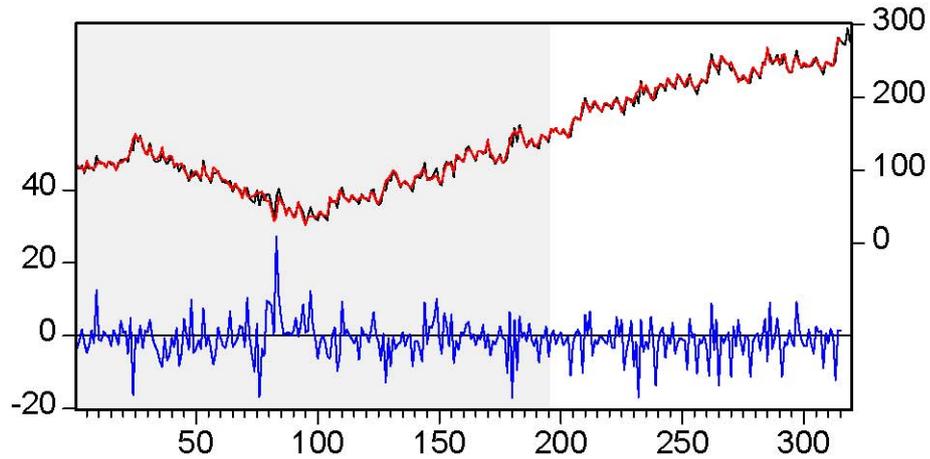
Notes: The spread between the average MRO rate and the marginal rate, $r_w - r_m$ (MRO spread), (right scale) and the deviations of the marginal MRO rate from the Eonia, $r_m - i_b$ (MR spread), valid immediately before the auction t (left scale). For further details see Figure 1.

Figure 3: The cover to bid ratio



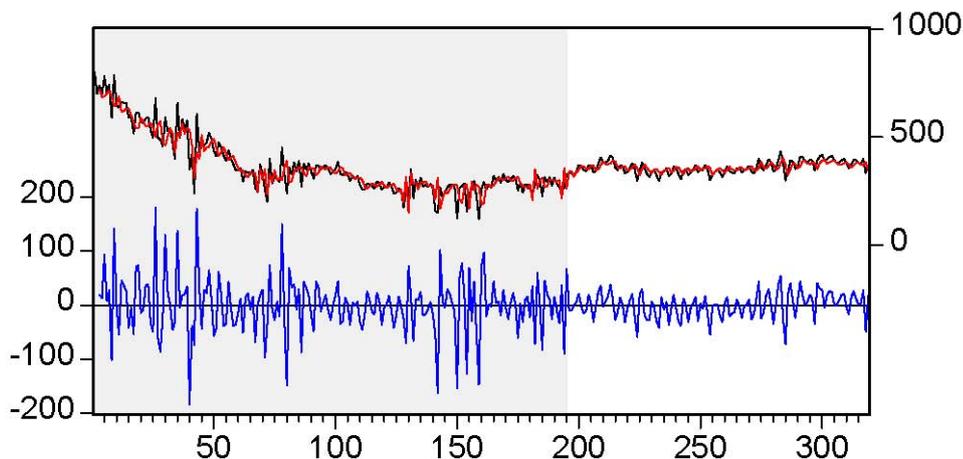
Notes: Bank's total bid volume (red line, right scale, in EUR billions) and ECB's total allotment (black line, right scale, in EUR billions) and the cover to bid ratio (left scale). For further details see Figure 1.

Figure 4: Actual minus forecasted autonomous factors (in EUR billions)



Notes: Actual autonomous factors (black line, right scale) and forecasted autonomous factors (red line, right scale) and their difference (left scale). For further details see Figure 1.

Figure 5: The number of bidders



Notes: Actual (black line, right scale), forecasted (red line, right scale) and the unexpected number of bidders (left scale). For further details see Equation (2) and (3).

A.2 Forecast equation of number of bidders

The unexpected number of bidders is included in order to control for the declining time trend during our sample, see Figure 5. Following e.g. Bindseil et al. (2004) determined this variable by regressing the number of bidders (B_t) in the current auction (t) on the number of bidders in previous auctions. With respect to the changes in seasonality and maturity in the ECB's operational framework as of March 2004⁷, we estimated two different forecast equations for each subperiod:

$$\begin{aligned}
 B_t^{OldFramework} &= \frac{19.56}{(12.06)} + \frac{0.37}{(0.07)} B_{t-1} + \frac{0.56}{(0.07)} B_{t-2} \\
 &- \frac{66.35}{(14.75)} D_t^{Underbid} + \frac{92.45}{(31.96)} D_{t-1}^{Underbid} + \frac{41.19}{(17.25)} D_{t-2}^{Underbid},
 \end{aligned} \tag{2}$$

for the sample prior to March 2004 and

⁷The Governing Council of the ECB presented in 2003 two basic changes in the operational framework, becoming operative in March 2004: First, the timing of the reserve maintenance period was adjusted to the Governing Council meetings at which the monthly assessment of the monetary policy stance was pre-scheduled. Currently, the subsequent maintenance period starts on the settlement day of the first MRO after the Council's meeting. Second, the maturity of MROs was reduced from two weeks to an one week tenor.

$$B_t^{NewFramework} = 149.64 + 0.59B_{t-1} - 28.98D_t^{Underbid} + 3.23D_{t-1}^{Underbid}, \quad (3)$$

(22.35)
(0.06)
(2.47)
(2.47)

after March 2004 and where white heteroskedasticity-consistent standard errors are reported in parentheses. We have also included the dummy variable to account for underbidding episodes⁸ occurred in auction t , i.e. $D_t^{Underbid} = 1$.

⁸The underbidding episodes refer to the MROs on 13 Feb, 10 Apr, 9 Oct and 6 Nov 2001, 3 Dec and 17 Dec 2002, 3 Mar, 3 Jun and 25 Nov 2003, 20 Feb and 23 Mar 2004, see Bindseil (2005).