Strategic Bidding in ECB Refinancing Operations

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ECB

Structural changes in money markets: Implications for monetary policy implementation
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Eurosystem Monetary Policy Implementation

- Banks need liquidity to fulfill reserve requirements
- ECB computes that amount ("benchmark") and
- auctions it off in weekly/monthly auctions
- If *aggregate* liquidity needs not met: recourse to standing facilities (MLF/DF) $\Rightarrow$ EONIA $\neq$ MRO-rate
- Historically
  - EONIA a few basis points above MRO-rate ▸ EONIA & MRO-rate
  - Benchmark "errors" matter only in the last MP week

Tender outcomes are translated into the interbank market
$\Rightarrow$ Clear need to understand banks' (bidding) behavior

Liquidity/Funding Sources

- Liquidity sources
  - Banking system: only ECB
  - Individual bank: Market or ECB

How Borrow From ECB?

- ECB refinancing operations with two maturities
  - Main Refinancing Operations (MRO)
    $\Rightarrow$ one week maturity (weekly)
  - Longer Term Refinancing Operations (LTRO)
    $\Rightarrow$ three months maturity (monthly)
- Tender procedure
  - Announcement on day t at 15:30 ▸ Announcement
  - Banks can bid until $t+1$, 9:30
  - Results published at 11:20
- Sequencing within Maintenance Period

$$MRO_1 \underbrace{\ldots}_{1week} MRO_2 \underbrace{\ldots}_{1day} LTRO \underbrace{\ldots}_{1week} MRO_3 \underbrace{\ldots}_{1week} MRO_4$$

$\Rightarrow$ Banks' problem: design a joint strategy for all operations

Auction Theory & Eurosystem Operations (1)

What to test

- Fear of a short squeeze in secondary market $\Rightarrow$ aggressive bidding (Nyborg and Strebulaev, 2001/2004)
- Asymmetric initial positions determine outcome
- Effect of uncertainty: winner's curse vs. losers nightmare (Milgrom and Weber, 1982)
- Bigger auctions $\Rightarrow$ aggressive bidding (Välimäki, 2006)
- Central bank asymmetric loss function increases tender spread (Ayuso and Repullo, 2003)

Auction Theory & Eurosystem Operations (2)

Applications with Eurosystem auction data

- No winner's curse in MROs, more aggressive bidding if dispersed liquidity needs (Bindseil 2009)
- Evidence of winner's curse in LTRO, size dependent reaction to exogenous factors (Linzert 2007)
- More aggressive & polarization of bidding behavior during crisis (Eisenschmidt 2009)
- Higher turmoil bid rates due to "real" demand & best-response by good banks (Cassola, forthcoming)
- Over/underbidding in fixed rate tenders (Ayuso and Repullo 2001; Ewerhart 2012; Nautz & Oechlser 2003/2006; . . .)

Motivation & Questions

- So far relatively little focus on joint MRO & LTRO bidding
  - Increasing LTRO award: less aggressive MRO bidding (substitutes)
  - Lower share of MROs & unchanged total liquidity provision: more aggressive MRO bidding (no subst.)
- Are LTRO and MRO substitutes?
  - Three months & one week money are rather different goods
    $\Rightarrow$ No real option for frequent "voluntary" switching
  - Different groups of bidders ▸ Refinancing Share
- Is there scope for "smart" joint strategies for MRO & LTRO?
  $\Rightarrow$ Examine joint bidding along time dimension

Lessons from Sequential Bidding

Empirical findings from auctions

- Bidders bid lower if similar items are expected to be sold soon
- Bidders with large demand bid lower: spread bids over time
- Bid rates are in(de)creasing over a sequence of auctions

Some hypotheses

- Asymmetric relation between MRO & LTRO: MRO can be "test run" in MRO-LTRO-bundle
- MROs after LTROs: some banks might have missed two allotment targets
- Banks deciding to bid in MRO and LTRO can
  - spread their bids over time and
  - can bid less aggressively in more MROs

Preview of Results & Policy Conclusions

Banks

- Bid less aggressively before and more aggressive after LTROs
- Followed a less aggressive bid strategy over a sequence of MROs if bidding in following LTRO
- Bid less aggressively before the LTRO if bid in following LTRO

Policy implications?!

- Change something in the framework?
- Depends on
  - transmission to the market
  - decision makers' utility function

A Roadmap

- Descriptive statistics
- Persistence of bidding strategies
- Econometric analysis
  - Use established covariates and add variables related to
    - timing
    - bid strategies
  - random effects, robust s.e, clustering on MFI level
- Data from period 16/10/2001-21/08/2007
- Excluding underbid operations

Variables

- Dependent variable

$$\text{Discount} = \text{Market Rate - Avg. Bid Rate}$$
$$\uparrow \quad \Rightarrow \text{less aggressive bidding}$$

- Award ratio
  - Allotment volume / bid volume
- Relative bid quantity
  - Individual bid volume / benchmark allotment

- Position of MRO relative to LTRO: pre/post/other

$$MRO_1 \underbrace{\ldots}_{1week} MRO_2 \underbrace{\ldots}_{1day} LTRO \underbrace{\ldots}_{1week} MRO_3 \underbrace{\ldots}_{1week} MRO_4$$

Descriptive Statistics - Cross Section

Table : Endogenous Variables: Pre/Post/Other MROs

	Pre			Post			Other		
Variable	Small	Med	Large	Small	Med	Large	Small	Med	Large
Discount	1.07	1.51	1.60	-0.85	-0.13	0.34	0.54	1.11	1.35
Award Ratio	0.92	0.87	0.86	0.94	0.90	0.86	0.93	0.89	0.85
Rel. Bid Quant.	0.01%	0.10%	1.19%	0.01%	0.09%	1.19%	0.01%	0.10%	1.22%

- Size determined according to MRR ▸ Imputation Procedure
- Ranking holds also using aggregate weighted average

Descriptive Statistics - Conditional Bidding

Table : Endogenous Variables: Conditional Bidding Behavior

Panel (A): Bidding in MRO

	Not Bid in LTRO			Bid in LTRO		
Group	Small	Medium	Large	Small	Medium	Large
Discount	0.27	0.84	1.15	0.38	1.01	1.18
Award Ratio	0.90	0.86	0.82	0.90	0.80	0.78
Rel. Bid Quant.	0.01%	0.09%	1.06%	0.01%	0.12%	1.44%
Participation	0.14	0.27	0.37	0.40	0.59	0.78
p(Participation)	0.22	0.35	0.46	0.56	0.74	0.87

Panel (B): Relative Participation & p(Participation)

LTRO=1/LTRO=0	Small	Med	Large
Participation	2.8	2.2	2.1
p(Participation)	2.5	2.1	1.9

Bidding Persistence

- Ho do banks bid over time?
  1. Put bank into a quintile of a tender's distribution of discounts
     High quintile $\Rightarrow$ high discount (low bid rate)
  2. Generate transition matrices (quintiles = "states")
  3. Sum up probabilities to move up conditional on LTRO participation

Table : Probabilities to move in the transition matrix

	Panel (A) - Δ in p(move up)			
Quintile	All	Small	Medium	Large
1	4.1	1.0	3.4	5.1
2	7.2	2.0	6.0	8.5
3	7.7	4.5	6.6	6.2
4	4.6	7.6	4.9	1.8
5	-	-	-	-

▸ Transition Matrices

▸ Participation / Drop-Out Matrices

Regressions: Explanatory Variables

- Dependent variable: Discount
- Include a number of variables capturing e.g.
  - New operational framework
  - Bank size
  - Success in past operations
  - Last operation in MP / Year
  - Uncertainty
  - Expected interest rates
  - Opportunity costs
  - ...
- Variables capturing timing
  - Position of MRO relative to LTRO: pre/post/other
  - Bidding strategies

Regressions: Results Simple Dummies

Table : MRO Regressions

	Pre/Post Dummy	Conditional Dummy	Pre-LTRO Sample
New Framew.	0.950***	0.947***	2.685***
Medium	0.520***	0.517***	0.236*
Large	0.659***	0.653***	0.196
Delta Awrat. LT	0.071***	0.074***	-0.079**
Delta Awrat. MR	-0.078***	-0.080***	-0.076**
Last MR MP	-0.185***	-0.185***	-0.910***
Last MR Year	-7.508***	-7.510***	-7.329***
Uncertainty	-0.291***	-0.291***	-0.188***
Swap Spr.	0.185***	0.185***	0.294***
Forw. Spr.	-0.087***	-0.087***	-0.001
Award Imb.	-1.206***	-1.208***	-3.707***
Benchmark	-0.004***	-0.004***	-0.013***
Outst. LTRO	-6.E-08*	-6.E-08*	-2.E-08
Pre LTRO	0.399***		
Pre LTRO L=0		0.371***	
Pre LTRO L=1		0.466***	
Post LTRO	-0.671***	-0.671***	
Bid in LTRO			0.18***
Constant	1.706***	1.713***	1.660***
R^2	0.30	0.30	0.43
N	98661	98661	23001
F		7.72	

Regressions: Define Bidding Strategies

- Banks have four choices per maintenance period
  - Bid in pre, post, or other MROs
  - Bid in LTRO

    e.g. $\sigma_{i,t} = \{r_1, s_1, o_0, L_1\}$ bid in pre/post-LTRO and LTRO

    $\Rightarrow$ characterize strategy by a dummy
- *Within* strategy:
  - add position of MRO using dummies $\sigma_{i,t}|r_1$ and $\sigma_{i,t}|s_1$

$\Rightarrow$ Complete characterization of strategies with 24 dummies

- Examine differences in bidding
  - conditional on a bid strategy
  - within the observed sequence

Regressions: Results Complete Strategies (1)

Strategy			All
MRO	LTRO	Pos.	
r/o		r	0.449***
r/o	y	r	0.770***
r/o		o	0.120**
r/o	y	o	0.251***
s/o		o	0.373***
s/o	y	o	0.153***
s/o		s	-1.738***
s/o	y	s	-0.403***
r/s		r	1.593***
r/s	y	r	1.219***
r/s		s	0.333*
r/s	y	s	-0.732*
r/s/o		r	0.509***
r/s/o	y	r	0.620***
r/s/o		s	-0.271***
r/s/o	y	s	-0.213***
r/s/o		o	-0.070*
r/s/o, cons.	y	o	1.334***
o		o	1.507***
o	y	o	0.707***
r		r	1.164***
r	y	r	1.203***
s		s	-1.747***
s	y	s	-1.846***
R^2			0.33
N			98661

Strategy	All
r/o	0.00
r/s	0.20
r/s/o	0.01
r	0.86
Joint 1	0.01
Joint 2	0.60

- Highest discount for bid in pre-LTRO
- Frequent bidders ("r/s/o") bid at "moderate" rates
- Occasional bidders "most extreme"

Regressions: Results Complete Strategies (2)

Complexity reduction

- Group pre-LTRO operations by bid frequency
- Use one dummy for all other operations

Strategy			All
MRO	LTRO	Pos.	
r/o & r/s		r	0.669***
r/o & r/s	y	r	0.930***
bid 2 op			-0.081**
r/s/o		r	0.535***
r/s/o	y	r	0.654***
bid 3 op			-0.129***
r/s/o, cons.	y	o	1.040***
r		r	1.264***
r	y	r	1.305***
bid 1 op			1.132***
R^2			0.31
N			98661

Strategy	All
r/o | r/s	0.01
r/s/o	0.00
r	0.85
Joint 1	0.00
Joint 2	0.95

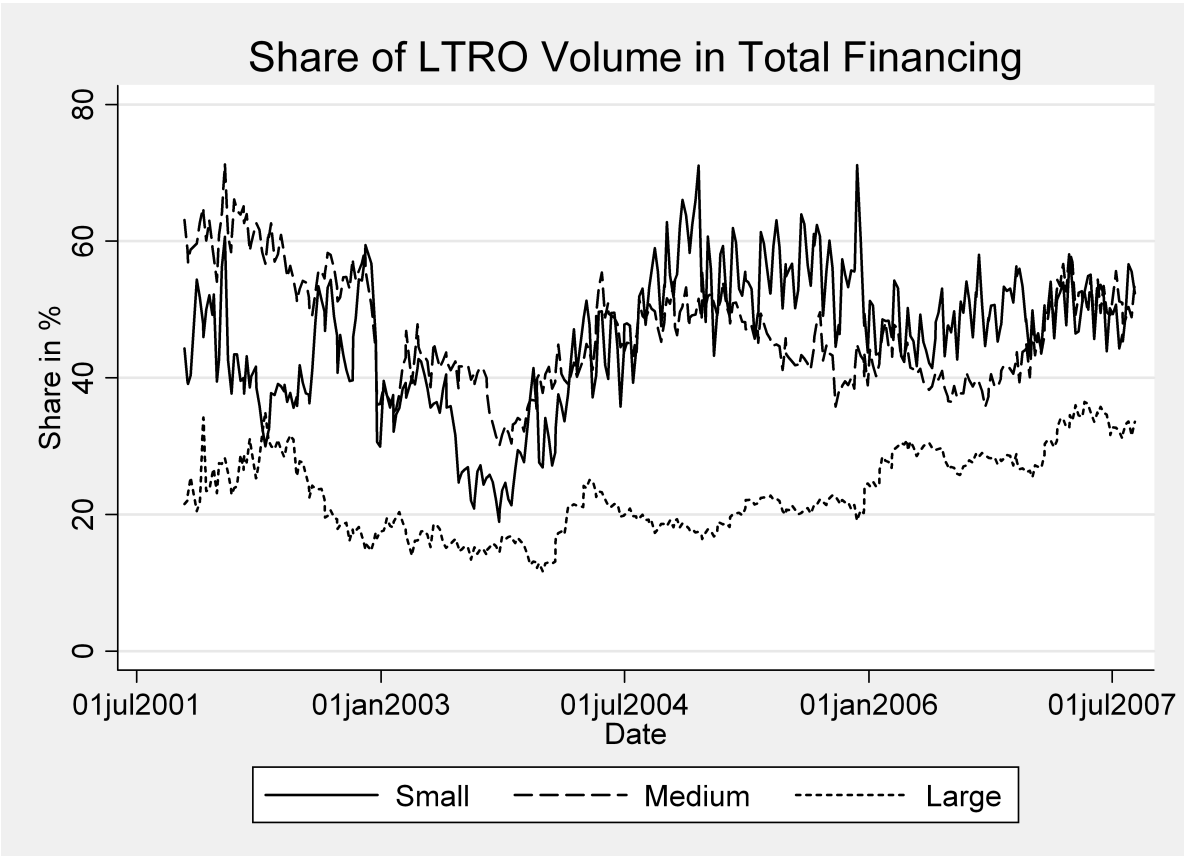
- Pre-LTRO bidders with higher discount
- No difference for occasional bidders (pre-LTRO)

Conclusions

- Banks bid less (more) aggressively before (after) the LTRO
  - General pattern but more pronounced for occasional bidders
- In MROs before the LTRO, banks bid at lower rates if they also bid in the LTRO
  - solid evidence from simple exercises
  - weaker evidence from "complete" strategies
- If bidding in the LTRO, banks are
  - less likely to drop out from MROs (or not participate),
  - following a less aggressive bid strategy in a MRO-sequence
- Policy implications
  - Should we care about the "bumps"?
    $\rightarrow$ preferences and transmission
  - Eliminate LTROs altogether?
  - Adjust duration/timing of LTRO?

The Importance of LTROs

Figure : Share of LTROs



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Transition Matrices

Table : No Bid in LTRO

	0	1	2	3	4	5
0	**94.8**	1.6	0.9	0.8	0.9	1.0
1	16.0	**56.3**	15.6	5.8	4.2	2.1
2	15.3	24.9	**33.5**	12.1	9.4	4.7
3	17.4	14.3	16.2	**26.0**	20.1	6.1
4	17.0	10.1	11.3	14.3	**32.0**	15.3
5	22.9	6.4	8.2	8.2	17.6	**36.7**
	76.9	7.9	4.8	3.3	4.0	3.1

Δ p($\uparrow$)| $Q_t = 3$: 20.1+6.1=26.2

Table : Bid in LTRO

	0	1	2	3	4	5
0	**81.2**	4.6	2.8	3.0	3.8	4.6
1	11.3	**56.8**	16.6	7.5	5.3	2.5
2	10.6	23.6	**32.4**	14.5	12.6	6.3
3	10.7	12.5	14.6	**28.4**	25.4	8.4
4	9.2	6.6	10.5	15.4	**38.5**	19.9
5	13.7	4.1	7.1	8.0	21.8	**45.4**
	38.3	15.8	10.8	9.7	13.9	11.6

Δ p($\uparrow$)| $Q_t = 3$: 25.4+8.4=33.8

Participation/Dropping-Out Probabilities

Table : Conditional Bidding Probabilities in MROs

	Not Bid in LTRO		Bid in LTRO	
	Out_t	Bid_t	Out_t	Bid_t
Out_{t-1}	94.8	5.2	81.2	18.8
Bid_{t-1}	17.2	82.9	11.0	89.0
$p(Out_t)/p(Bid_t)$	76.9	23.1	38.3	61.8

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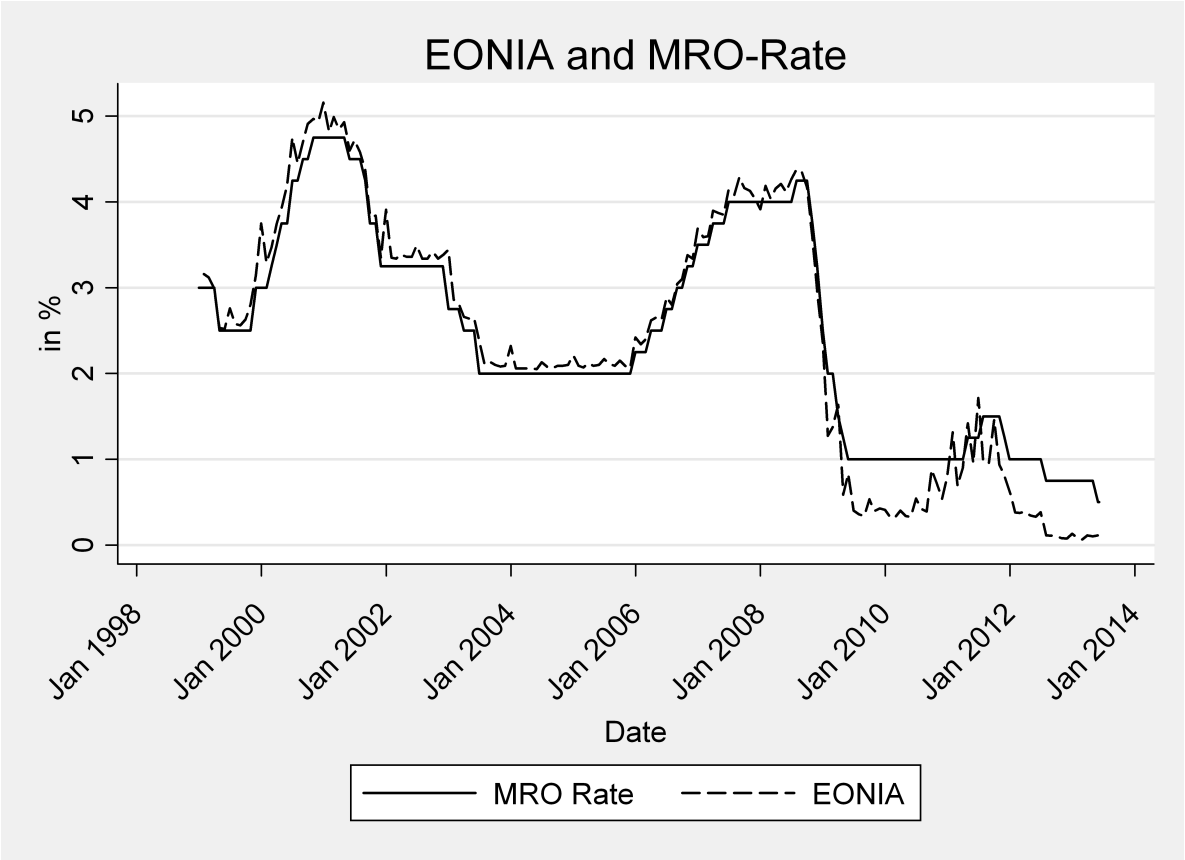
EONIA and MRO-Rate

Figure : EONIA and MRO-Rate



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Regression Results - Complete Strategies All Samples (1)

Table : MRO Bid Rate Regressions: Complete Strategies

	All	New	Old
New Framew.	1.181***		
Medium	0.602***	0.520***	0.595***
Large	0.792***	0.756***	0.644***
Δ Awrat. MR	-0.147***	-0.011	-0.116***
Δ Awrat. LT	0.081***	-0.005	0.234***
Last MR MP	-0.171***	0.216***	-0.575***
Last MR Year	-7.596***	-7.424***	-9.179***
Uncertainty	-0.306***	-0.385***	-0.202***
Swap Spr.	0.185***	0.132***	0.329***
Forw. Spr.	-0.088***	-0.084***	-0.085***
Award Imb.	-1.261***	2.026***	-1.695***
Benchmark	-0.005***	-0.006***	0.008***
Outst. LTRO	-7.E-08**	-2.E-08	7.E-08

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Regression Results - Complete Strategies All Samples (2)

Strategy			All	New	Old
MRO	LTRO	Pos.			
r/o		r	0.449***	0.938***	-0.495***
r/o	y	r	0.770***	1.096***	0.080
r/o		o	0.120**	0.252***	-0.386***
r/o	y	o	0.251***	0.243***	-0.090
s/o		o	0.373***	0.086	0.331***
s/o	y	o	0.153***	0.135	0.142**
s/o		s	-1.738***	-0.151	-2.305***
s/o	y	s	-0.403***	-0.160	-0.533***
r/s		r	1.593***	0.752***	1.476***
r/s	y	r	1.219***	1.423***	0.500*
r/s		s	0.333*	-0.266	-0.259
r/s	y	s	-0.732*	-0.771***	-1.860***
r/s/o		r	0.509***	0.655***	0.069
r/s/o	y	r	0.620***	0.719***	0.237***
r/s/o		s	-0.271***	-0.286***	-0.530***
r/s/o	y	s	-0.213***	-0.241***	-0.503***
r/s/o		o	-0.070*	-0.025	-0.162***
r/s/o, cons.	y	o	1.334***	2.508***	-0.146
o		o	1.507***	0.332***	1.571***
o	y	o	0.707***	0.173**	0.848***
r		r	1.164***	0.721***	0.952***
r	y	r	1.203***	0.678***	0.790***
s		s	-1.747***	-0.766***	-2.900***
s	y	s	-1.846***	-0.950**	-3.477***

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Regression Results - Complete Strategies All Samples (2)

Table : Robustness Check of Selection Procedure

	Participation	Discount	IMR	β
IMR		1.473***		
New Framew.	0.099***	1.139***	-0.075***	-0.108
Medium	0.651***	1.277***	-0.489***	-0.703
Large	1.438***	2.334***	-1.037***	-1.224
Δ Awrat. LT	0.025***	0.089***	-0.018***	-0.014
Δ Awrat. MR	-0.086***	-0.112***	0.062***	0.052
Last MR MP	0.000	-0.202***	0.000***	0.000
Last MR Year	-0.014	-7.605***	0.010***	0.004
Uncertainty	0.003*	-0.295***	-0.002***	-0.010
Swap Spr.	0.002**	0.189***	-0.001***	-0.018
Forw. Spr.	0.000	-0.089***	0.000***	-0.007
Award Imb.	0.391***	-0.658***	-0.292***	-0.066
Benchmark	0.000***	-0.004***	0.000***	-0.100
Outst. LTRO	0.000***	0.000***	0.000***	-0.031
Pre LTRO	0.018***	0.404***	-0.013***	-0.017
Post LTRO	-0.024***	-0.713***	0.017***	0.021
Constant	-1.622***	-1.619**	1.982***	
R^2	0.093	0.304	0.996	
N	347170	98661	347170	

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Imputation of MRR

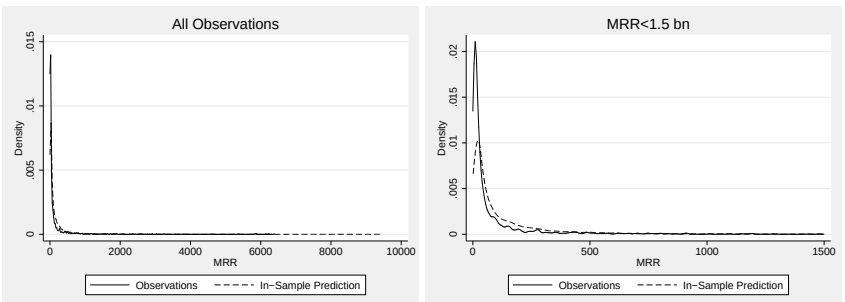
Two-step imputation procedure

- Compute avg. bid amount per MP/bank ($\bar{b}$)
- Estimate per country a model with $mrr = f(\bar{b})$ and make prediction for missings
- Use imputed MRR to group banks

Table : Distribution of Banks

Group	Observed	Imputed
Small	42.8%	45.3%
Medium	39.9%	38.6%
Large	17.2%	16.1%

Figure : Backfitting MRR Imputation



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