Kiel Institute
for the World Economy

Liquidity Intermediation in the Euro Money Market

Falko Fecht
Frankfurt School of Finance and Deutsche Bundesbank

Stefan Reitz
IfW and QBER, Kiel

Bundesbank/SAFE conference, Frankfurt,
October 22, 2013

The paper represents the authors‘ personal opinions and do not necessarily reflect the views of the Deutsche Bundesbank

Outline of the talk

1. Motivation
2. A Stylized Model
3. Data
4. Empirical Analysis
5. Conclusions

Motivation

- Money markets
  - play pivotal role in the conduct of monetary policy
  - important for capital allocation and risk sharing between banks
- Recent experience showed that limited access to liquidity could severely stress otherwise healthy banks and destabilize the financial system
- Observers even talked about a complete freeze of the market

Motivation

- Interestingly, we know very little about the trading process in the European money market
- More than 80% of the trading occurs in an over-the-counter fashion
  (The rest is trading via the Italian e-MID platform)
- Interest rates are agreed on a bilateral basis and remain unpublished
- Complete trading records are undisclosed preventing the knowledge of the exact terms of a trade
- (Counterparty risk, maturity, time of the day,….)

Motivation

- What has been done so far is to infer market tensions from
  - indicative quotes (bid/ask)
  - EONIA/EURIBOR surveys and derivative measures such as the EURIBOR-OIS spread
  - filtered data from payment system transactions
  - e-MID data

What we do…

- Make use of a propriety data set, which contains the complete set of transactions of a market maker in 2007 and 2008 hereby covering the most important period of the crisis in the money market
- Estimate a market microstructure model to infer the trading behavior of a major market maker
- Assess the relative importance of asymmetric information in times of crisis

Theoretical Model

- Money market trading (OTC)
- Banks trade among each other
- No trading platform
- Asymmetric (private) information important
- Leads to an augmented version of the Madhavan and Smidt (1991) pricing model

Theoretical Model

- Full-information price of the overnight interest rate offered to a specific counterparty is supposed to follow a martingale process

$$\upsilon_t = \upsilon_{t-1} + d_t^1 + d_t^2 \quad d_t^1, d_t^2 \sim iid\ N(0, \sigma_{1,2}^2)$$

- Increments represent
  - market dynamics of excess liquidity
  - Counterparty's idiosyncratic risk in excess of group-specific risk

Theoretical Model

- Market maker sets quotes according to

$$p_t = \mu_t - \gamma(I_t - I_t^*) + \delta M_t + \rho C_t + \psi D_t,$$

- Customer bank's belief about the true price of liquidity

$$z_t = \theta w_t + (1 - \theta) y_t,$$

- Customer bank's excess demand for liquidity is

$$q_t = \alpha(z_t + \delta M_t + \rho C_t - p_t) + x_t$$

Theoretical Model

- Following Glosten and Milgrom (1985) the market maker considers that order flow is based on a private piece of information
- Bayesian learning gives a post-trade expected value

$$\mu_t = \pi y_t + (1-\pi)(p_t - \delta M_t - \rho C_t + \frac{1}{\alpha} q_t)$$

- Inserting into the pricing equation gives

$$p_t = \pi y_t + (1-\pi)(p_t - \delta M_t - \rho C_t + \frac{1}{\alpha} q_t) - \gamma(I_t - I_t^*) + \delta M_t + \rho C_t + \psi D_t$$

Theoretical Model

- Pricing eq. cannot be estimated directly because y_t is an unobservable variable
- Madhavan and Smidt (1991) solution is

$$y_t = p_{t-1} + \gamma(I_{t-1} - I^*) - \delta M_{t-1} - \rho C_{t-1} - \psi D_{t-1} + \eta_t$$

- The resulting estimation equation is

$$\Delta p_t = (\tfrac{1}{\pi} - 1)\gamma I^* + \tfrac{(1-\pi)}{\alpha\pi} q_t + \delta \Delta M_t + \rho \Delta C_t -$$

$$\tfrac{\gamma}{\pi} I_t + \gamma I_{t-1} + \tfrac{\psi}{\pi} D_t - \psi D_{t-1} + \eta_t,$$

Data

- Tick-by-tick data from a major money market dealer
- Data from Jan. 1st, 2007 to Dec. 31th, 2008
  (510 trading days, 17,888 transactions)
- Trade records contain
  - date and time of trade
  - trade direction
  - deal size
  - transaction price
  - maturity
  - counterparty type and trade initiator

Data

Table 1: Descriptive statistics across maturity
510 trading days between Jan 2, 2007 – Dec 31, 2008

	First	Second	Third	Full sample
Trading days	154	280	76	510
sum	5594	8581	3713	17888
Deposit (%)	86.22	81.38	95.39	85.80
Loan (%)	13.78	18.62	4.61	14.20
Number of trades				
O/N	3800	5811	2564	12175
Up to 7 days	1610	2423	983	5016
8 to 30 days	134	268	136	538
31 to 60 days	30	59	23	112
61 to 90 days	10	6	5	21
91 to 180 days	9	12	2	23
Beyond 180 days	1	2	0	3
Sum	5594	8581	3713	17888

Data

Table 2: Descriptive Statistics Across Ratings and Day Time
510 trading days between Jan 2, 2007 – Dec 31, 2008

	First	Second	Third	Full sample
	Counterparty rating			
Number of loans				
AAA	69	178	72	319
AA	497	966	39	1502
A	129	410	59	598
BBB	12	22	1	35
BB	0	0	0	0
B	1	3	0	4
CCC	0	0	0	0
NR	63	19	0	82
Sum	771	1598	171	2540

Data

Table 2: Descriptive Statistics Across Ratings and Day Time
510 trading days between Jan 2, 2007 – Dec 31, 2008

	First	Second	Third	Full sample
	Counterparty rating			
Number of deposits				
AAA	123	83	73	279
AA	516	945	501	1962
A	686	708	485	1879
BBB	286	497	265	1048
BB	627	1022	340	1989
B	124	335	98	557
CCC	24	4	21	49
NR	2437	3389	1759	7583
Sum	4823	6983	3542	15348

Data

Table 2: Descriptive Statistics Across Ratings and Day Time
510 trading days between Jan 2, 2007 – Dec 31, 2008

	First	Second	Third	Full sample
	Day Time			
Number of Loans				
Morning	177	490	98	765
Noon	92	234	28	354
Afternoon	502	874	45	1421
Sum	771	1598	171	2540
Number of Deposits				
Morning	547	674	361	1582
Noon	1600	1851	1201	4652
Afternoon	2676	4458	1980	9114
Sum	4823	6983	3542	15348

Empirical Analysis

Additional control variable

- Relationship trading (Cocco et al., 2009)? Is there a discount for frequent trading with the dealer? Include number of trades before the crisis (NoT)
- Deal size often turns out to be part of transaction cost pricing schemes. Additionally use deal size in excess of its median (ExMed)
- Δp_t shows significant autocorrelation
  $\rightarrow$ inclusion of lagged price changes up to eighth order
- Δp_t also driven by monetary policy decisions
  $\rightarrow$ inclusion of EONIA changes (current and lagged)

Empirical Analysis

- Split up sample:
  First: Jan. 2007 to Aug. 2007
  Second: Aug. 2007 to Sept. 2008
  Third: Sept. 2008 to Dec. 2008
- GMM with Newey-West covariance correction
- Set of instruments equals the set of regressors (OLS estimates, but do not rely on a specific error distribution)
- R^2s nearly 50%, *DW* in the neigborhood of 2

Table 3: Spread Variation Across Day Time

510 trading days between January 2, 2007 – December 31, 2008 (17,399 obs.)

		First	Second	Third	Full Sample
NoT		1.40 (0.11)***	0.78 (0.08)***	0.31 (0.11)***	0.76 (0.05)***
Deal Size	morning	-7.76 (2.26)***	-4.08 (1.35)***	2.38 (5.37)	0.27 (1.41)
	noon	-6.30 (1.81)***	1.59 (1.59)	1.03 (5.69)	-2.39 (1.58)
	aftern.	-7.64 (1.63)***	-3.66 (1.46)**	-14.92 (2.02)***	-6.27 (1.08)***
ExMed	morning	11.26 (3.81)***	5.43 (2.16)**	3.44 (9.75)	1.16 (2.17)
	noon	4.55 (2.33)*	-1.88 (2.14)	-5.45 (6.13)	2.09 (2.01)
	aftern.	6.56 (2.30)***	5.56 (2.70)**	15.16 (3.07)***	6.59 (1.71)***
Inventory	morning	-0.67 (0.70)	-0.91 (0.58)	-8.36 (3.05)***	-2.16 (0.59)***
	noon	-0.90 (0.77)	-1.19 (0.60)**	-8.99 (2.47)***	-2.82 (0.61)***
	aftern.	-1.15 (0.75)	-1.84 (0.64)***	-10.33 (2.65)***	-3.21 (0.62)***
Inventory(-1)	morning	1.65 (0.75)**	1.63 (0.61)***	9.90 (2.84)***	3.34 (0.61)***
	noon	1.00 (0.77)	1.63 (0.60)***	8.85 (2.46)***	3.04 (0.61)***
	aftern.	1.37 (0.75)*	1.97 (0.65)***	10.56 (2.63)***	3.35 (0.63)***

Table 3: Spread Variation Across Day Time

510 trading days between January 2, 2007 – December 31, 2008 (17,399 obs.)

		First	Second	Third	Full Sample
Direction	morning	5.88 (0.77)***	6.31 (0.65)***	15.47 (2.60)***	7.83 (0.65)***
	noon	6.16 (0.71)***	6.00 (0.40)***	17.22 (2.08)***	7.38 (0.53)***
	aftern.	7.53 (0.66)***	10.40 (0.49)***	16.84 (2.01)***	9.59 (0.38)***
Direction(-1)	morning	-1.70 (0.67)**	-4.05 (0.48)***	-14.27 (2.15)***	-5.96 (0.55)***
	noon	-1.55 (0.62)**	-3.91 (0.40)***	-15.93 (2.01)***	-5.02 (0.49)***
	aftern.	-2.00 (0.60)***	-7.28 (0.47)***	-16.73 (2.03)***	-6.85 (0.40)***
ΔCredit		3.49 (1.07)***	0.05 (0.16)	4.37 (1.48)***	0.50 (0.19)***
ΔMat		0.91 (0.12)***	0.40 (0.02)***	0.40 (0.06)***	0.42 (0.03)***
EONIA(-1)		0.45 (0.10)***	0.16 (0.02)***	0.17 (0.03)***	0.18 (0.02)***
EONIA(-2)		0.18 (0.06)***	0.07 (0.01)***	0.07 (0.03)**	0.07 (0.01)***
R^2		0.46	0.49	0.48	0.43
DW		2.00	2.11	2.16	2.10

Table 4: Spread Variation Across Deal Size

510 trading days between January 2, 2007 – December 31, 2008 (17,399 obs.)

		First	Second	Third	Full Sample
NoT		1.36 (0.11)***	0.78 (0.07)***	0.33 (0.11)***	0.73 (0.05)***
Deal Size		-3.76 (1.25)***	-5.45 (1.12)***	-7.94 (2.94)***	-3.03 (0.91)***
ExMed		5.92 (1.68)***	6.90 (1.55)***	5.47 (3.55)	3.27 (1.24)***
Inventory	Small	-1.48 (1.05)	-0.46 (0.58)	-10.17 (3.32)***	-2.10 (0.81)***
	Med	0.76 (0.97)	-2.06 (2.03)	-13.48 (4.64)***	-1.82 (1.41)
	Large	0.18 (0.61)	-0.95 (0.58)	-6.07 (1.53)***	-1.24 (0.42)***
Inventory(-1)	Small	1.61 (1.05)	0.77 (0.58)	10.50 (3.30)***	2.34 (0.80)***
	Med	-0.56 (0.99)	2.47 (2.06)	13.64 (4.57)***	2.18 (1.43)
	Large	0.19 (0.61)	0.76 (0.60)	5.64 (1.61)***	1.26 (0.44)***
Direction	Small	7.96 (0.69)***	8.37 (0.56)***	14.64 (1.89)***	8.47 (0.44)***
	Med	6.40 (0.67)***	8.93 (0.57)***	16.44 (2.06)***	8.40 (0.43)***
	Large	3.77 (0.67)***	9.60 (0.63)***	20.11 (1.97)***	8.41 (0.48)***
Direction(-1)	Small	-2.79 (0.60)***	-5.78 (0.53)***	-14.09 (1.89)***	-5.99 (0.42)***
	Med	-1.41 (0.66)**	-6.11 (0.56)***	-16.36 (2.03)***	-6.16 (0.46)***
	Large	-0.51 (0.64)	-6.08 (0.63)***	-16.95 (2.26)***	-5.57 (0.51)***

Table 4: Spread Variation Across Deal Size

510 trading days between January 2, 2007 – December 31, 2008 (17,399 obs.)

		First	Second	Third	Full Sample
ΔCredit	Small	-0.67 (1.33)	0.87 (0.58)	10.15 (4.04)**	1.23 (0.72)*
	Med	7.15 (1.59)***	1.66 (0.39)***	12.29 (2.03)***	2.68 (0.48)***
	Large	5.06 (1.15)***	-0.69 (0.22)***	2.60 (1.46)*	0.11 (0.20)
ΔMat	Small	0.93 (0.12)***	0.41 (0.02)***	0.38 (0.06)***	0.42 (0.03)***
	Med	0.92 (0.13)***	0.39 (0.02)***	0.39 (0.06)***	0.42 (0.03)***
	Large	0.74 (0.15)***	0.40 (0.03)***	0.42 (0.06)***	0.49 (0.03)***
EONIA(-1)		0.45 (0.10)***	0.17 (0.02)***	0.16 (0.03)***	0.18 (0.02)***
EONIA(-2)		0.18 (0.06)***	0.07 (0.01)***	0.06 (0.03)**	0.07 (0.01)***
R^2		0.47	0.48	0.48	0.44
DW		2.02	2.10	2.22	2.11

Conclusions

- Propose an OTC money market pricing model
- Accounting for microstructure issues such as
- adverse selection
- inventory control
- counterparty-specific spreads
- Increasingly unbalanced trading
  Funds from an increasing number of depositors were lend to a decreasing number of borrowers

Conclusions

- During the course of the crisis
  - Half spreads increased substantially
  - Inventory considerations and counterparty risk became more important
  - Confidence in order flow information decreased
  - Information aggregation process severely hampered
- Money market trading severely stress, but not frozen