

# Market Transparency and Traders' Behavior :

## An Analysis on Euronext with Full Order Book Data

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# OUTLINE

- Motivation & contributions
- Research question
- Data
- Methodology
- Results
- Conclusion

# MOTIVATION

- Proliferation of limit order markets
- Most trading systems moved towards greater transparency
- Use of hidden quantities becomes a widespread practice

Euronext, Toronto, Sydney, Inet ATS,  
Nasdaq, MTS...

# CONTRIBUTIONS

- Accurate results about hidden liquidity for a large sample
- Impact of hidden depth on implicit transaction costs
- Impact of hidden depth on traders' behavior

# TRANSPARENCY LEVEL on Euronext

- ✓ What market participants see on their screens
  - *The displayed quantities available at the different bid and ask prices*
  - *The number of orders contributing to the depth at the different bid and ask prices*
- ✓ What they do not see on their screens
  - *ID codes*
  - *Hidden quantities (from iceberg orders)*

## How to guess the presence of hidden depth ?

H_Bid	Qty Bid	Bid	Ask	Qty Ask	H_Ask
0	400	50.00	52.00	800	2500
1100	500	49.60	52.20	500	1250
0	250	49.50	52.30	300	0
1000	300	49.30	52.60	100	0
550	300	49.00	53.00	700	1000

Market buy order for a quantity of 300 shares

# RESEARCH QUESTION

Which information is used by traders for order placement?

- Do traders use information they can directly observe in the LOB ? Which pieces of info ?  
  
→ *Griffiths, Smith, Turnbull & White (2000), Ranaldo (2004), ...*
- Do traders also use information they can infer by monitoring LOB movements (presence of hidden orders) ?

# DATA

- **Public data:** orders & trades  
+ some additional private data
- **Limit order book data:**  
both displayed and hidden quantities  
at each limit price in the whole order book
- **Sample:**  
82 stocks (CAC40, AEX & BEL20)  
October to December 2002  
(64 trading days)  
→ **About 20 million of LOB states**  
(continuous session)



## Presence of HO at the best quote

Index	$HO_{Bid}$	$HO_{Ask}$	$Dur_0^{Bid}$	$Dur_1^{Bid}$	$Dur_0^{Ask}$	$Dur_1^{Ask}$
AEX	23.72%	24.25%	27.0	7.8	25.5	7.5
BEL	23.46%	25.54%	28.3	7.6	27.4	8.4
CAC	28.53%	27.94%	23.3	8.7	24.4	8.7
All	26.01%	26.35%	25.5	8.2	25.4	8.3

When there are some hidden quantities at the best Bid/Ask, they are present during more than 8 successive states !



# METHODOLOGY

## *Our order aggressiveness classification*

**Category 1:** orders that consume the whole displayed depth at the best opposite quote

**Category 2:** orders that consume part of the displayed depth at the best opposite quote

**Category 3:** orders improving the best price on the same side

**Category 4:** orders increasing the depth at the best quote

**Category 5:** other orders

# METHODOLOGY

## Ordered-probit model

Latent equation :

$$\begin{aligned}
 A_t &= \beta_1 \cdot \text{Spread}_t + \beta_2 \cdot \text{Depth}_{1,t}^S + \beta_3 \cdot \text{Depth}_{1,t}^O \\
 &\quad + \beta_4 \cdot \text{Depth}_{+,t}^S + \beta_5 \cdot \text{Depth}_{+,t}^O \\
 &\quad + \beta_6 \cdot \text{Hidden}_t^S + \beta_7 \cdot \text{Hidden}_t^O + \varepsilon_t \\
 &= X_t + \varepsilon_t \quad \text{where } \varepsilon_t \sim N(0, \sigma_t^2)
 \end{aligned}$$

Ordered response :

$$\text{Cat} = \begin{cases} 1 & \text{if } A_t \leq \gamma_1 \\ m & \text{if } \gamma_{m-1} < A_t \leq \gamma_m, m = 2 \dots 4 \\ 5 & \text{if } A_t > \gamma_4 \end{cases}$$

# RESULTS:

## Order aggressiveness

Index	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : Buy orders									
AEX	23	22	23	22	15	17	5	22	23
BEL	19	17	15	18	7	7	6	9	13
CAC	40	40	40	40	32	37	16	40	40
Panel B : Sell orders									
AEX	23	22	23	22	17	21	2	22	23
BEL	19	17	16	19	6	5	9	12	16
CAC	40	40	40	40	30	38	15	40	40

Aggressive orders are more frequent when bid-ask spreads are narrow [Ranaldo (2004)]

# RESULTS:

## Order aggressiveness

Index	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : Buy orders									
AEX	23	22	23	22	15	17	5	22	23
BEL	19	17	15	18	7	7	6	9	13
CAC	40	40	40	40	32	37	16	40	40
Panel B : Sell orders									
AEX	23	22	23	22	17	21	2	22	23
BEL	19	17	16	19	6	5	9	12	16
CAC	40	40	40	40	30	38	15	40	40

The deeper the market on the same side, the more aggressive the subsequent orders.

c. The deeper the market on the opposite side, the less aggressive the orders.

# RESULTS:

## Order aggressiveness

Index	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : Buy orders									
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BEL	19	17	15	18	7	7	6	9	13
CAC	40	40	40	40	32	37	16	40	40
Panel B : Sell orders									
AEX	23	22	23	22	17	21	2	22	23
BEL	19	17	16	19	6	5	9	12	16
CAC	40	40	40	40	30	38	15	40	40

If hidden orders are present at the best quote on the same side, traders need to submit orders that are at least as aggressive as these hidden orders

# RESULTS:

## Order aggressiveness

Index	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : Buy orders									
AEX	23	22	23	22	15	17	5	22	23
BEL	19	17	15	18	7	7	6	9	13
CAC	40	40	40	40	32	37	16	40	40
Panel B : Sell orders									
AEX	23	22	23	22	17	21	2	22	23
BEL	19	17	16	19	6	5	9	12	16
CAC	40	40	40	40	30	38	15	40	40

Orders tend to be more aggressive when hidden depth is present at the best opposite quote

*See Pardo & Pascual (2004) &*

*De Winne, D'Hondt & François-heude (2004)*

<i>Aggressiveness</i>	<i>All</i>	<i>HS = 0</i>	<i>HS = 1</i>	<i>HO = 0</i>	<i>HO = 1</i>
Panel A : buy orders					
1	16.68	16.63	16.83	15.76	19.13***
2	16.22	16.25	16.09	15.72	17.58***
3	17.61	17.64	17.59	17.95	16.71***
4	20.40	20.04	21.47***	20.65	19.70***
5	29.08	29.44	28.02***	29.93	26.87***
Panel B : sell orders					
1	17.18	17.15	17.26	16.28	19.48***
2	17.44	17.48	17.31	16.88	18.87***
3	17.22	17.31	17.02	17.58	16.44***
4	19.65	19.21	20.81**	19.86	19.07***
5	28.50	28.84	27.61***	29.41	26.14***

# CONCLUSION

Traders are able to infer the presence of hidden orders by monitoring LOB movements and they use this piece of information for order placement

*⇔ Hidden depth is important to understand traders' behavior!*

# CRT : AEX

Stock	ME order size			Q3 order size			P99 order size		
	<i>N</i>	<i>CRT</i> <sup>a</sup>	<i>CRT</i> <sup>r</sup>	<i>N</i>	<i>CRT</i> <sup>a</sup>	<i>CRT</i> <sup>r</sup>	<i>N</i>	<i>CRT</i> <sup>a</sup>	<i>CRT</i> <sup>r</sup>
65996	225943	0.169	0.165	225943	0.198	0.187	225943	0.526	0.423
65997	380542	0.130	0.128	380542	0.146	0.141	380542	0.265	0.246
65999	770003	0.091	0.089	770003	0.114	0.108	770003	0.246	0.217
66000	598542	0.184	0.174	598542	0.220	0.201	598442	0.709	0.568
66002	200493	0.198	0.192	200489	0.221	0.210	200485	0.503	0.423
66005	278050	0.215	0.208	278050	0.245	0.231	278017	0.836	0.636
66013	221357	0.308	0.292	221357	0.355	0.323	221357	1.164	0.846
66014	246685	0.258	0.252	246685	0.297	0.283	245304	0.821	0.706
66694	430603	0.220	0.211	430603	0.256	0.240	430550	0.645	0.547
66695	457603	0.211	0.203	457603	0.259	0.240	457589	0.686	0.576
66696	471941	0.226	0.216	471941	0.275	0.254	471918	0.778	0.634
66699	608701	0.172	0.167	608701	0.206	0.195	608657	0.603	0.509
66704	432546	0.246	0.237	432546	0.297	0.276	432424	0.835	0.669
66708	408767	0.308	0.291	408767	0.362	0.331	408676	1.177	0.928
66730	119246	0.762	0.737	119246	0.833	0.794	119124	2.082	1.830
66746	324905	0.264	0.251	324905	0.282	0.266	324905	0.709	0.603
66756	87407	0.209	0.203	87407	0.252	0.235	87407	0.572	0.468
66757	113100	0.688	0.659	113100	0.762	0.713	112899	1.818	1.500
66760	114808	1.453	1.447	114808	1.596	1.574	114712	2.509	2.376
66784	88218	0.563	0.552	88218	0.624	0.602	88146	1.424	1.278
66796	154265	0.504	0.487	154265	0.568	0.535	154265	1.578	1.288
66838	239481	0.278	0.267	239481	0.321	0.295	239481	1.011	0.717
66850	196795	0.328	0.309	196795	0.381	0.345	196795	1.002	0.745
AEX	7170001	0.255	0.246	7169997	0.296	0.278	7167641	0.784	0.645



# Results by trader status

Index	B/S	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : orders for clients										
AEX	B	23	22	23	23	13	0	11	21	22
AEX	S	23	21	23	23	7	5	7	21	22
BEL	B	19	16	16	16	6	5	7	8	13
BEL	S	19	15	15	19	6	5	9	11	16
CAC	B	40	40	40	40	24	18	36	37	40
CAC	S	40	39	40	40	23	25	31	38	40
Panel B : orders for own account										
AEX	B	23	22	23	21	19	20	2	22	23
AEX	S	23	22	23	22	18	22	0	22	23
BEL	B	19	15	12	14	2	5	0	10	10
BEL	S	19	17	11	15	5	5	0	6	6
CAC	B	40	40	40	40	29	40	2	40	40
CAC	S	40	40	40	40	29	40	2	40	40
Panel C : orders from liquidity providers										
AEX	B	1	0	0	0	1	0	0	0	0
AEX	S	1	0	0	0	0	0	0	1	1
BEL	B	3	3	3	3	3	0	0	0	1
BEL	S	3	2	3	2	1	1	0	0	1



# Results according to time

Index	B/S	N	Spread < 0	$Depth_1^S$ > 0	$Depth_1^O$ < 0	$Depth_+^S$ > 0	$Depth_+^O$ < 0	$Hidden^S$ > 0	$Hidden^O$ > 0	LR
Panel A : orders during first 30 minutes										
AEX	B	23	21	22	18	10	10	1	12	13
AEX	S	23	20	21	20	9	10	1	15	17
BEL	B	19	9	9	9	1	2	1	5	6
BEL	S	19	11	9	11	2	5	1	3	4
CAC	B	40	40	39	39	18	12	6	38	38
CAC	S	40	40	37	40	20	23	2	38	38
Panel B : orders around US markets opening										
AEX	B	23	22	23	19	15	13	5	19	23
AEX	S	23	22	23	22	7	15	1	19	20
BEL	B	19	15	13	14	5	4	2	6	7
BEL	S	19	12	9	14	2	3	3	4	6
CAC	B	40	40	40	40	28	29	14	37	38
CAC	S	40	40	40	40	25	33	16	38	40
Panel C : orders during last 30 minutes										
AEX	B	23	21	23	21	11	11	6	15	19
AEX	S	23	22	22	23	15	14	3	16	17
BEL	B	19	13	10	9	5	5	1	5	6
BEL	S	19	13	11	8	2	2	1	4	6
CAC	B	40	40	40	40	17	24	11	33	35
CAC	S	40	40	40	40	23	31	8	38	39

# Buy orders for AEX stocks

Stock	Spread	Depth <sub>1</sub> <sup>S</sup>	Depth <sub>1</sub> <sup>O</sup>	Depth <sub>+</sub> <sup>S</sup>	Depth <sub>+</sub> <sup>O</sup>	Hidden <sup>S</sup>	Hidden <sup>O</sup>	LR
65996	-3.5287***	0.1032***	-0.0613***	0.0170**	-0.0475***	0.0166*	0.1025***	130.4201***
65997	-3.5885***	0.1557***	-0.1640***	0.0461***	-0.0352***	0.0576***	0.0320***	105.8929***
65999	-6.9377***	0.0958***	-0.0732***	0.0493***	-0.0352***	0.0250***	0.1139***	461.1353***
66000	-9.9760***	0.0983***	-0.0871***	0.0490***	-0.0458***	-0.0090*	0.1260***	666.2332***
66002	-1.9287***	0.0849***	-0.0332***	0.0005	-0.0210***	-0.0287***	0.0618***	45.8336***
66005	-3.4674***	0.0971***	-0.0421***	0.0594***	-0.0230***	0.0032	0.0714***	81.7127***
66013	-5.0682***	0.1107***	-0.0484***	0.0419***	-0.0350***	0.0224***	0.1063***	155.0042***
66014	-18.2095***	0.1110***	-0.1259***	0.0492***	-0.0327***	0.0127*	0.0351***	29.1206***
66694	-8.8988***	0.1069***	-0.0759***	0.0141***	-0.0050	-0.0010	0.1232***	354.8889***
66695	-12.1545***	0.0924***	-0.0927***	0.0360***	-0.0469***	-0.0181***	0.0985***	281.9313***
66696	-12.7110***	0.0917***	-0.0907***	0.0347***	-0.0219***	-0.0150***	0.1112***	432.1865***
66699	-11.5055***	0.0998***	-0.0941***	0.0571***	-0.0506***	-0.0278***	0.1558***	1096.2937***
66704	-9.2730***	0.1019***	-0.0810***	0.0163***	-0.0296***	0.0134**	0.0792***	198.8832***
66708	-10.6415***	0.0791***	-0.0808***	0.0237***	-0.0414***	-0.0381***	0.1245***	500.5494***
66730	-4.3817***	0.0664***	-0.0443***	0.0539***	0.0690***	0.0029	0.0978***	74.7404***
66746	-6.8084***	0.1590***	-0.0366***	0.0113	-0.0033	0.0438***	0.0442***	55.1794***
66756	-1.0551***	0.0862***	-0.0576***	-0.0214*	-0.0730***	-0.0684***	0.0590***	47.1636***
66757	-2.4038***	0.0874***	-0.0250***	-0.0221***	-0.0170**	-0.0256**	0.0520***	27.3773***
66760	-2.2478	0.0999***	-0.0979***	0.0274***	0.0057	0.0163	-0.0267**	7.1192**
66784	-1.6937***	0.0599***	0.0155***	0.0034	0.0096	-0.0656***	0.0940***	52.4760***
66796	-2.5159***	0.1200***	-0.0191***	0.0035	-0.0276***	-0.0361***	0.1150***	123.3691***
66838	-2.7557***	0.1026***	-0.0392***	0.0070	-0.0201***	-0.0010	0.0994***	152.7713***
66850	-3.8693***	0.1206***	-0.0299***	0.0061	0.0154**	0.0095	0.1064***	140.3744***