Informational linkages between dark and lit trading venues

Sugata Ray

joint with Mahendrarajah Nimalendran

June 2012

Motivation

- What are dark pools/crossing networks
  - Relatively new equity market design
  - As opposed to limit order books (and other quoting markets)
  - Networks look for matches and prices trades relative to quoting exchanges (generally at mid)

- Why do we care?
  - 13% of US equity markets now
  - Fast growth
  - Regulatory debate: do these disadvantage traders who can't access them, do they harm price discovery, how much disclosure should they provide

Questions in our study

- Is there information in trades in dark pools? How do we measure it? Where is it concentrated?
    - Almost all theoretical models suggest including CNs in strategy set helps maximize profits for informed traders
    - However, results critically dependent on parameters of model (shelf life of information, liquidity in CNs, depth of limit order book, how correlated is the information)
- What is the transmission mechanism for this information? (assuming there is such information)
    - Which way does information go? From lit to dark or dark to lit?
    - Since it is hard to observe dark pool transactions and orders do not interact with "lit" liquidity, what is transmission mechanism? How long does it take?

Academic understanding so far

- Theory papers - Zhu (2011 WP), Ye (2009 WP), Buti et al (2010 WP), Hendershott and Mendelson (2000 JF) - Model dark pools and more traditional markets structures and use models to predict where informed traders will trade. Levers in the models include: shelf life of information, liquidity of dark pool, time horizon to execute trades, proportion of noise traders, etc.

- Empirical papers - Gresse (2006 EFM), WPs: Boni, Brown and Leach (2012), Ready (2009), Weaver (2010), Buti et al (2010), Ray (2010) - no differentiation between different types of dark pool orders and trades; large focus on explaining cross-sectional variation of dark pool market share. Some newer empirical papers (including ours) using more granular data (e.g. BBL 2012 - Exclusivity of dark pools matters; Naes Odegaard (2007 JFM) - adverse execution)

Details of the data and representativeness

- Discussed academic literature with contact at CN and asked for data
- Data is confidential and provided on condition of anonymity - provider is a major independent CN
- Selected a list of 100 tickers, spread evenly across market cap, bid ask spreads, primary exchange, SIC codes (with slightly higher weight on large caps) - transaction data from June 2009 to Dec 2009 on the CN
- Tickers are representative, CN constitutes 5.8% of of CN market share over this period (in line with what it normally constitutes)
- CN space is quite fragmented (40-50 CNs, the biggest has 10-15% market share, a few have 5-10% market share)

Details of counterparties - there are different types of transactions on dark pools!

Brokerage Desk Like any other agency, often times a crossing network will "work" large orders for some of the customers on their system.

Member negotiated Trades involving two large "natural" traders that are manually negotiated. The defining characteristics of these types of trades is that they are large and manually negotiated. The average trade size in our sample is around 60,000 shares.

Member algo Trades between members or between a member and external liquidity supplied from another dark venue. These trades are generally small and numerous. They are most likely generated by an algorithm that is designed either to minimize transactions costs or to trade for a profit.

Summary Statistics: Counterparties

Volume (Total =355MM shares)

	External	Member	Total
Desk	11.7	0.6	12.3
Member Algo	25.6	2.8	28.4
Member Negotiated	2.4	56.9	59.3
Total	39.6	60.4	100.0

No of trades (Total = 490K)

	External	Member	Total
Desk	35.8	0.0	35.8
Member Algo	63.4	0.1	63.5
Member Negotiated	0.1	0.6	0.7
Total	99.3	0.7	100.0

Summary Statistics: Pricing deviations from mid (DFM) of NBBO

DFM (dollars)	Fraction of transactions (%)
-0.02 or less	3.48
-0.02 to -0.01	3.69
-0.01	10.59
-0.01 to 0	24.99
0.00	36.35
0.00 to 0.01	12.89
0.01	1.96
0.01 to 0.02	0.70
0.02 or more	5.37

Most trades occur away from the mid.

Summary Statistics: Signed trades

Volume (Total =355MM shares)

	Sell	Unsigned	Buy	Total
Desk	3.80	6.10	2.50	12.30
Member Algo	7.70	17.00	3.80	28.40
Member Negotiated	2.90	53.50	2.90	59.30
Total	14.30	76.50	9.10	100.00

No of trades (Total = 490K)

	Sell	Unsigned	Buy	Total
Desk	15.50	11.60	8.60	35.80
Member Algo	27.20	24.10	12.20	63.50
Member Negotiated	-	0.60	-	0.70
Total	42.70	36.30	20.90	100.00

Main tests

- What goes on in lit markets around dark pool trades?
    - What happens before? What happens after?
    - Focus on bid ask spreads and directional order flow

- Are signed trades in dark pools profitable?
    - This is our best measure for information on dark pools
    - If there is information in dark transactions, signed trades should be profitable and stay that way

Median market conditions - average, 10 min before and 10 min after

	Average	Before	After
BA Spread	0.191	0.115	0.117
Volatility	0.077	0.027	0.027
Volume	11,375	13,416	13,912

Dark pool trades occur at times of lower volatility, lower bid ask spreads and slightly higher volume.

Average change in percentage spreads following a CN transaction - 10 min before vs. 10 min after

Liquidity	Desk	Negotiated	Member Algo	Total	Base (median)
Liquid	0.006	0.004(NS)	0.016	0.012	0.061
2nd quint.	-0.008	-0.020	0.005	0.001	0.151
3rd quint.	-0.027	-0.043	-0.005	-0.010	0.447
4th quint.	0.014	0.014(NS)	0.033	0.026	1.048
Illiquid	0.220	0.057(NS)	0.315	0.294	5.185
Total	0.001	-0.012	0.013	0.009	0.103

The spread increases after dark pool trades. All significant to at least a 5% level except those marked (NS)

Change on change regression I

$\Delta s_{10} = \alpha + \sum_i \beta_i g_{i,t} + \epsilon$ where Δs_{10} is the change in the average quoted percentage spread from 10 min before transaction to 10 minutes after

	All	Desk	Member Neg.	Member Algo
α	0.010*	-0.000	-0.007	0.014*
	(2.036)	(-0.115)	(-1.055)	(2.228)
R-squared	0.118	0.086	0.125	0.131
N	225003	78388	1332	145268

Controls: Change in volume, change in volatility, market cap

Interpretation: On average, after any trade on a CN, the spread increases by 1.0bp. After a trade by a member using algorithms, the spread increases by 1.4bp.

Change on change regression II

$\Delta s_{10} = \alpha + \sum_i \beta_i g_{i,t} + \epsilon$ where Δs_{10} is the change in the average quoted percentage spread from 10 min before transaction to 10 minutes after

	Liq. desk	Illiq. desk	Liq. Neg	Illiq. Neg	Liq. Algo	Illiq. Algo
α	-0.001	0.048+	-0.008+	0.048	0.008+	0.133*
	(-0.451)	(1.889)	(-1.902)	(0.887)	(1.966)	(2.238)
R2	0.070	0.212	0.037	0.287	0.092	0.231
N	66203	4201	906	154	109072	9495

Controls: Change in volume, change in volatility, market cap

Interpretation: On average, after a trade by a member using algorithms for an illiquid stock, the spread increases by 13.3bps

Do signed CN trades make money? Long buys and short sells - Returns over next hour I

	Ret(bp)	T-stat	N
Sell	-2.0	-4.05	73,204
Unsigned	-1.5	-3.17	67,292
Buy	11.9	10.11	35,684
Buy - Sell	13.9	10.89	

Signed trades make money - portfolio makes 13.9bps over the hour. Suggests motivated traders have some information. Returns persist over 2 hour horizon so unlikely to be illiquidity + slow moving capital, but we cannot rule that out.

Long buys and short sells - Returns over next hour II

Sample	Buy - Sell	T-stat
All trades	13.9	10.89
Most Liquid	-5.5	-11.65
Least liquid	520.2	6.70
Least liquid - member algo	749.5	7.60
Least liquid - CN desk	-73.1	-1.01

Be wary of trading an illiquid ticker on a CN against a motivated trader. Trade loses 5.2% in the next hour! At least the CN brokerage desk is not involved in this.

Regression: Returns on sign of trade

$r_{30} = \alpha + \sum_i \beta_i g_{i,t} + \epsilon$ where r_{30} is the return over the next 30 minutes and g_i are the explanatory variables

	Liq. desk	Illiq. desk	Liq. Neg	Illiq. Neg	Liq. Algo	Illiq. Alg
Sign (B=1,	0.003	0.042	-0.007	-0.080	-0.001	0.097*
S=-1,U=0)	(0.380)	(1.061)	(-0.102)	(-0.330)	(-0.056)	(2.436)
R2	0.003	0.019	-0.003	0.236	0.010	0.051
N	54250	3285	786	113	88631	6813

Control variables include historical returns
Interpretation: There are positive returns to signed trades.

How does the information flow? A look at order flow on lit exchanges around dark pool transactions

All trades	Previous	Next
Sell	0.08	-0.03
Unsigned	-0.10	-0.12
Buy	0.37	0.11
Overall	0.07	-0.04

Least Liquid	Previous	Next
Sell	-4.15	-4.22
Unsigned	-0.52	2.03
Buy	4.96	5.75
Overall	-0.97	-0.54

LL: MA	Previous	Next
Sell	-5.76	-4.45
Unsigned	-0.55	2.33
Buy	6.29	6.62
Overall	-1.38	-0.51

| LL: BD	Previous	Next
Sell	1.98	1.69
Unsigned	0.00	-2.57
Buy	-0.89	-2.80
Overall	1.02	-1.09

Recap of results

- There is likely to be information in dark pool transactions - evidence includes positive returns to signed trades, increased spreads after dark pool trades
- The information is concentrated in transactions by members using algorithms trading illiquid stocks
- Dark pools appear to be just another venue to transact - similar signed orders sandwiching dark pool signed orders; this aids in transmission of information
- The information is unlikely to be fundamental (unreported results where we redo all analysis for earnings periods and find no significant results/results directionally going the other way)

Conclusion

- Our interpretation: Informed traders using dark pools to max profits/reduce price impact as they take positions

- Alternative explanation: Large liquidity traders using dark pools to minimize price impact - but no reversion within 2 hours and small transactions size make this unlikely. In any case, knowledge of large liquidity is a form of information.

- Policy implications
  - Academics: There are many types of dark pool trades and lumping them all together may be counterproductive
  - Regulators - if we don't care about a slight delay in price discovery, maybe this is fine; improve post trade transparency for better research
  - Traders - Be wary of trading against motivated traders on CNs

Backup slides

Transactions on the CN over the course of the day
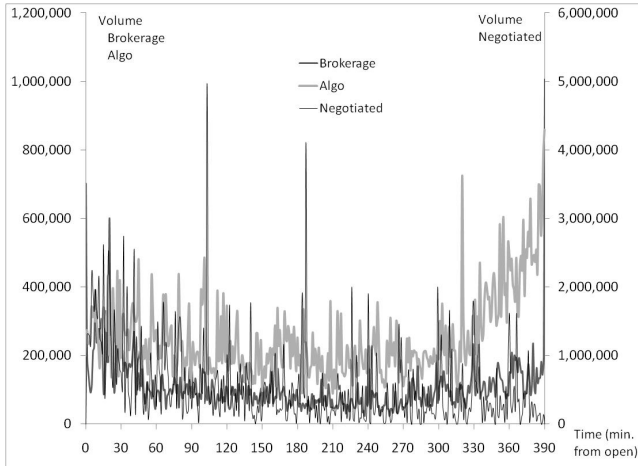
A limit order book within a limit order book
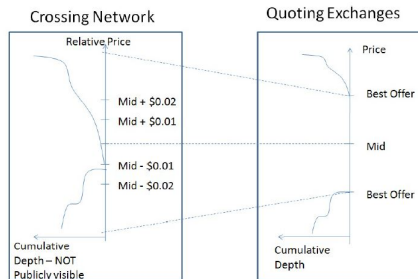
Zhu (2009): "Some dark pools passively match buyers and sellers at prices derived from transparent exchange; many others are essentially invisible limit order books that execute orders by price and time priority."

Earnings days - Spread analysis

	Desk	Negotiated	Member Algo	Total
Most Liquid	0.006	-0.002(NS)	-0.003	-0.001(NS)
2nd Liquid	-0.005(NS)	0.013(NS)	0.128	0.054
3rd Liquidi	0.019(NS)	-0.063	-0.016	-0.013
4th Liquid	0.209	-0.091(NS)	-0.024	-0.002(NS)
Least Liquid		No Observations		
Total	0.004(NS)	-0.021(NS)	0.012	0.010

Overall, spreads still increase. Spreads do not increase for illiquid tickers.

Earnings days - ST Return Analysis

Sample	Buy - Sell	T-stat
All trades	-42.5	-11.24
Most Liquid	12.6	3.57
Least liquid	-82.8	-9.33
Least liquid - member algo	-62.4	-8.73
Least liquid - CN desk	-123.9	-2.03

Signed trades underperform on earnings days - suggests motivated traders on CN do not have ST fundamental information.