Dark trading and price discovery

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Market Microstructure Confronting Many Viewpoints
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What is ‘dark’ trading?

Traditional stock exchange with ‘lit’ public limit order book

Dark trading

Trading with no pre-trade transparency

Public consolidated record of trades
The pros and cons

• Potential benefits include:
  – Additional liquidity and potentially block liquidity; and
  – Reduced market impact costs and info leakage

BUT

• Potential costs include:
  – Reduced incentives to display liquidity;
  – Fairness issues as dark orders step-ahead of lit;
  – Fragmentation of order flow;
  – Segmentation of order flow (no fair access requirements);
  – Lack of transparency around operations; and
  – Less efficient price discovery process
Our research questions

• We consider two types of dark trading:
  – Block
  – Non-block (we refer to this as dark)

• We answer three questions:
  – Where are informed and uninformed trades typically executed or how informative are lit, dark and block trades?
  – How does the level of dark and block trading impact adverse selection risk on the lit exchange?
  – What is the association between dark/block trading and price discovery?
Headline results

- Dark orders are less informed than lit orders
- Concentration of informed traders on lit book
- Increase in adverse selection risk, bid ask spread and price impact on lit market
- Quotes become more important in impounding information as dark trading increases
- Block and dark trades have different impacts
  - Low levels of dark trading can be beneficial, but high levels are harmful to informational efficiency
  - No evidence that block trades harm price discovery
Recent dark pool theory papers

- Zhu (2014): dark pools *improve* price discovery
  - More uninformed go to dark because they face better execution probability there relative to informed traders → concentrates info on the exchange

- Ye (2012): dark pools *harm* price discovery
  - Informed trader trades in both lit and dark, but reduces aggressiveness in lit market due to negative externality on his dark trading profits
Empirical setting

• Empirical research has been constrained by poor quality data
• Australian Securities Exchange (ASX) offers a number of benefits:
  – Complete picture of dark trading
  – Granular data with accurate time stamps for all trade types
  – No fragmentation in displayed liquidity
Empirical setting

- All trades executed under rules of exchange and reported to ASX
- Exceptions to pre-trade transparency:
  - Block and portfolio crossings (any price)
  - Priority crossings (at the quotes)
- New facilities introduced by ASX in June 2010:
  - Centre Point (separate dark order book)
  - Centre Point priority crossings
- Multiple dark broker crossing systems launched
Data

- All Ordinaries Index stocks (top 500 ASX stocks)
- Feb 2008 – Oct 2011 (avoid Chi-X impact)
- Order level data from SIRCA (AusEquities)
- Use flags to classify trades as:
  - **Lit** (central limit order book)
  - **Dark** (crossing systems, internalization, manually matched trades, Centre Point)
    - Flags: Centre Point trades, Centre Point crossings, Priority Crossings
  - **Block** ("block specials" and "portfolio specials")
    - Flags: Special Crossings
Dark trading in Australia

- 3 crossing syst. exist (UBS, Citi, CreditSuisse)
  Liquidnet enters
- 11 other crossing syst. commence during sample
- ASX Centre Point commences
- Chi-X enters and fragments lit liquidity

Bar graph showing dark trading volume from 2008 to 2012:
- Dark + block: 21% (10% of trades)
- Dark: 14% (0.1% of trades)
- Block: 7.0%
Dark trading in Australia – trade frequency

![Chart showing trade frequency over time with bars for total number of trades, Block %, Dark %, and Block & Dark %.]
Empirical strategy

• Estimate informational efficiency measures at a stock-date level:
  – Informativeness of different types trades
  – Spreads/adverse selection costs
  – Information shares (lit vs dark trades; trades vs midquotes)
    – Aggregate informational efficiency proxies

• Relate informational efficiency measures via stock-date panel regressions to:
  – Dark share of $ volume
  – Block share of $ volume
Format of panel regressions

\[ y_{id} = \alpha + \beta_{DARK}DARK_{id} + \beta_{BLOCK}BLOCK_{id} + \sum_{j=1}^{6} \delta_j C_{jid} + \varepsilon_{id} \]

- Dependent variables: informational efficiency measures
- Dark and Block measured as % of total $ value
- Control variables:
  - Log market capitalization
  - Log quoted spread
  - Proportion of stock-day during which spread is constrained at 1 tick
  - Log total $ volume
  - Midquote volatility (std dev of 1-minute midquote returns)
  - Ratio of messages to trades (algo trading proxy)
- Fixed effects: none, stock, date
- Standard errors: clustered by stock and by date
Dealing with endogeneity

• Two-stage instrumental variables tests using two different sets of instruments
  – Exploit market structure changes that influence dark trading but are exogenous with respect to price discovery characteristics of particular stocks
    • Removal of 10 second rule, change in fees, launch of Centrepoint, launch of broker-operated dark pools
  – DARK and BLOCK instrumented by the level of dark/block trading in other stocks in the size quartile (as per Buti et al. (2011), Hasbrouck and Saar (2012))

• IV regressions provide stronger results
Which trade type is more informed?

- Use Hasbrouck (1991) vector auto-regression (VAR) framework to measure informativeness of trades
- Calculate the informativeness of lit, dark and block volume as the cumulative impulse response of midquote returns for a shock of +$10,000 of signed lit, dark, and block volume, respectively, holding all other variables equal to their unconditional means

<table>
<thead>
<tr>
<th>PriceImpactLIT (bps/$10,000)</th>
<th>Mean</th>
<th>Median</th>
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<tbody>
<tr>
<td>PriceImpactDARK (bps/$10,000)</td>
<td>3.62</td>
<td>1.91</td>
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<tr>
<td>PriceImpactBLOCK (bps/$10,000)</td>
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<tr>
<td>PriceImpactBLOCK (bps/$10,000)</td>
<td>0.15</td>
<td>0.01</td>
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Do we observe wider spreads?

<table>
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<tr>
<th></th>
<th>Spread</th>
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<th>Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>DARK</td>
<td>0.006</td>
<td>0.020</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>(11.05)***</td>
<td>(10.23)***</td>
<td>(9.75)***</td>
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<tr>
<td>BLOCK</td>
<td>0.004</td>
<td>-0.006</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(7.52)***</td>
<td>(-1.3)</td>
<td>(-1.53)</td>
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<tr>
<td>Controls</td>
<td>All</td>
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<td>All</td>
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<tr>
<td>R²</td>
<td>0.74</td>
<td>0.75</td>
<td>0.75</td>
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<tr>
<td>Instruments</td>
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<td>Set 1</td>
<td>Set 2</td>
</tr>
</tbody>
</table>

- ↑ Dark from 0% to 10% of dollar volume → ↑ quoted spreads by 11% (128bps to 142bps for average stock)

- ↑ Dark from 10% to 12.5% → ↑ spreads by 2.2% (2.8 bps for average stock)
Information shares

- Information leadership share (ILS) adapted from Hasbrouck (1995) and Yan and Zivot (2010)
  - measures relative speed at which innovations in fundamental value are reflected ("who moves first" in price discovery)
- All measures based on a VECM decomposition into temporary/permanent components
- Estimated each stock-day using 1-second intervals
- Estimate for two price series:
  - lit trade prices vs dark/block trade prices
  - trade prices vs midquotes
Information shares

- Lit vs. dark information shares:
  - Lit trades impound more information than dark/block trades (mean = 0.75, median = 0.84)
  - As share of dark trading increases, contribution to price discovery increases at a slower rate than volume share → dark trades contain less information than lit trades

- Quote vs. trade information shares:
  - Midquotes impound slightly more information than trade prices (mean = median = 0.56)
  - As share of dark trading increases, contribution of quotes to price discovery increases → informed traders effective liquidity providers using limit orders
What happens to aggregate informational efficiency?

• Concentration of informed traders in lit market, and uninformed traders in the dark, changes incentives to become informed:
  – No change in the amount of private information held in aggregate by informed traders, higher concentration of informed traders will improve informational efficiency (consistent with Zhu (2014))
  Or
  – Endogenous and costly information acquisition → fewer investors become informed → decline in informational efficiency
Aggregate informational efficiency

1. **Autocorrelation** of midquote returns (Hendershott and Jones, 2005):
   \[ \text{Autocorrelation}_k = \text{Corr}(r_{k,t}, r_{k,t-1}) \]
   - Absolute value, then first principle component of: \( k \in \{10 \text{ sec}, 30 \text{ sec}, 60 \text{ sec}\} \)

2. **Variance ratio** (Lo and MacKinlay, 1988):
   \[ \text{VarianceRatio}_{kl} = \frac{\sigma_{kl}^2}{k\sigma_l^2} - 1 \]
   - First principle component of:
     (1sec, 10sec), (10sec, 60sec), (1min, 5min)

3. **Return predictability using lagged market returns** (Hou and Moskowitz, 2005), 1-minute midquote returns:
   \[ r_{i,t} = \alpha_i + \beta_i r_{m,t} + \sum_{k=1}^{10} \delta_{i,k} r_{m,t-k} + \varepsilon_{it} \]
   \[ \text{Inefficiency}_{\text{Delay}} = 100\left(1 - \frac{R^2_{\text{Constrained}}}{R^2_{\text{Unconstrained}}}\right) \]
Aggregate informational efficiency

<table>
<thead>
<tr>
<th></th>
<th>Autocorrelation Factor</th>
<th>VarianceRatio Factor</th>
<th>Delay</th>
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</thead>
<tbody>
<tr>
<td>DARK</td>
<td>0.042</td>
<td>0.029</td>
<td>0.048</td>
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<tr>
<td></td>
<td>(16.84)***</td>
<td>(17.75)***</td>
<td>(8.72)***</td>
</tr>
<tr>
<td>BLOCK</td>
<td>-0.013</td>
<td>-0.006</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(-5.15)***</td>
<td>(-3.55)***</td>
<td>(-0.26)</td>
</tr>
<tr>
<td>Control</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>R²</td>
<td>0.06</td>
<td>0.10</td>
<td>0.17</td>
</tr>
<tr>
<td>Fixed effects</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

1. Increasing share of dark trading $\rightarrow$ deterioration of informational efficiency

2. Not true for block trades: *improvement* in 2 of the 3 informational efficiency measures

3. Dark results consistent for low frequency measures
Aggregate info efficiency: nonlinearity?
 Aggregate info efficiency: nonlinearity?

![Graph showing the effect on informational inefficiency with respect to block dollar volume (% of total). The graph includes lines for Autocorrelation, Variance Ratio, and Delay, illustrating the relationship between these factors and the efficiency.](image-url)
Conclusions

• Dark trading relatively uninformed → concentrating informed traders on lit market
• Dark trading increases adverse selection risk, spreads and price impact on lit market
• Quotes become more informative relative to trades, with informed traders providing liquidity
• Low levels of dark trading benign or beneficial, but high levels of dark trading harms informational efficiency
• Block trades are not harmful
Policy implications

• Not all dark trading is the same
  – Block trading does not harm price discovery
  – Some dark trading is beneficial, but too much is harmful
• Regulatory action should consider existing dark trading at stock-level
• Action of European Commission to limit dark trading to 8% market wide, and 4% for individual venues may have unintended consequences
• Regulations need to carefully consider these differences