

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

TLS - TELSTRA CORPORATION LIMITED. ORDINARY FULLY PAID

Last/IAP	+/-	%	Open	High	Low	Volume	VWAP	Status	IAP
\$3.885	-0.005	-0.1%	\$3.890	\$3.920	\$3.880	18.23M	\$3.894743	Open	\$0.00

Buyers				Sellers			
Level	Orders #	Quantity	Price	Price	Quantity	Orders #	Level
+	1	105	2,251,132	\$3.880	\$3.890	1,622,925	46
+	2	56	1,725,866	\$3.870	\$3.900	1,474,199	60
+	3	67	1,866,369	\$3.860	\$3.910	1,369,873	49
+	4	112	1,558,586	\$3.850	\$3.920	1,417,181	43
+	5	37	997,298	\$3.840	\$3.930	1,006,268	43
+	6	39	923,661	\$3.830	\$3.940	971,263	37
+	7	33	375,336	\$3.820	\$3.950	1,896,532	42

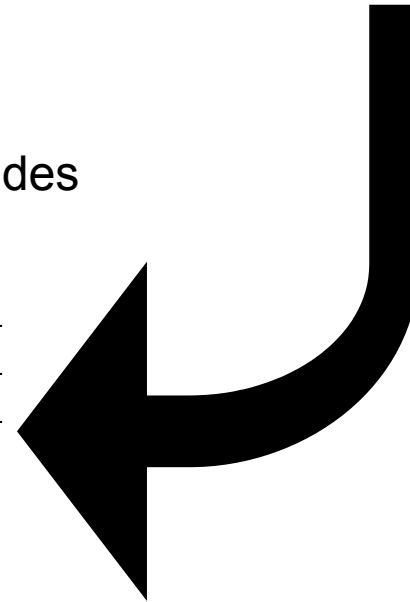
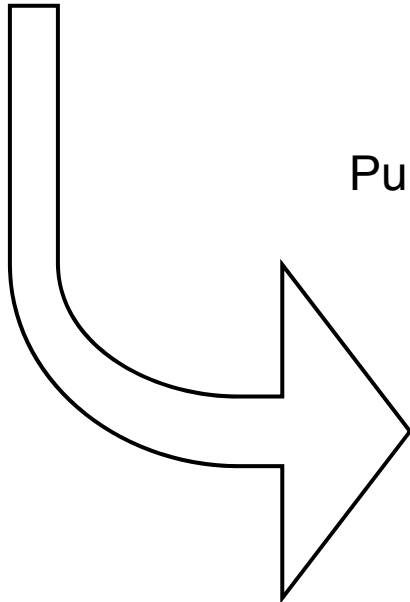
Dark trading

Trading with no pre-trade transparency

Public consolidated record of trades

Today's Trades (Time in AEST)

Time	TSN	Price	Quantity	
12:31pm	1640050832	3.885	1	CX ←
12:31pm	1640050737	3.885	500000	CX,XT ←
12:30pm	1640050634	3.885	15	CX ←
12:30pm	1640050607	3.890	8255	→
12:30pm	1640050534	0.000	0	→
12:30pm	1640050340	3.880	1030	XT →
12:30pm	1640050289	3.880	9	XT →
12:30pm	1640050243	3.885	12	CX ←



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

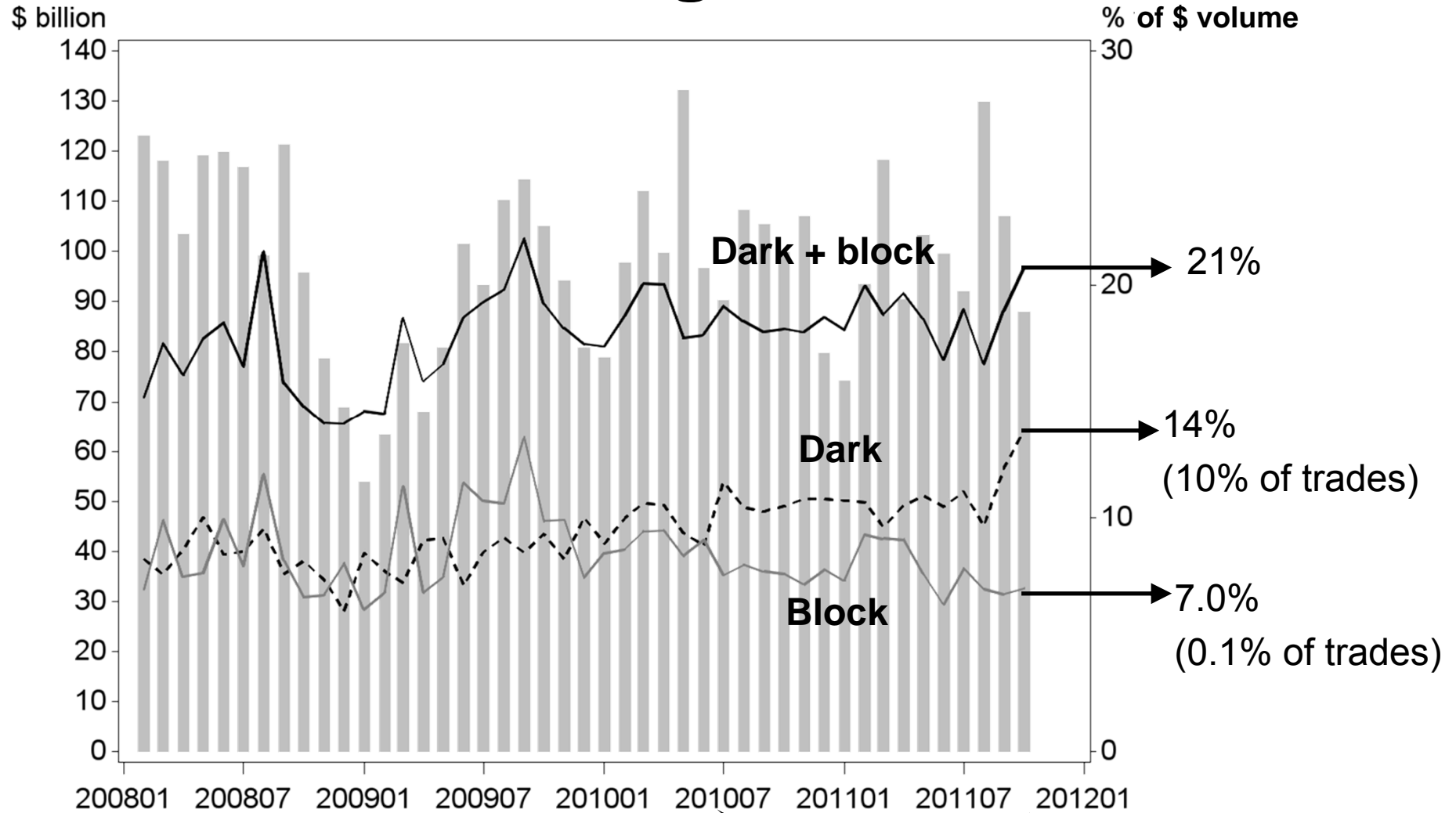
Empirical setting

- 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



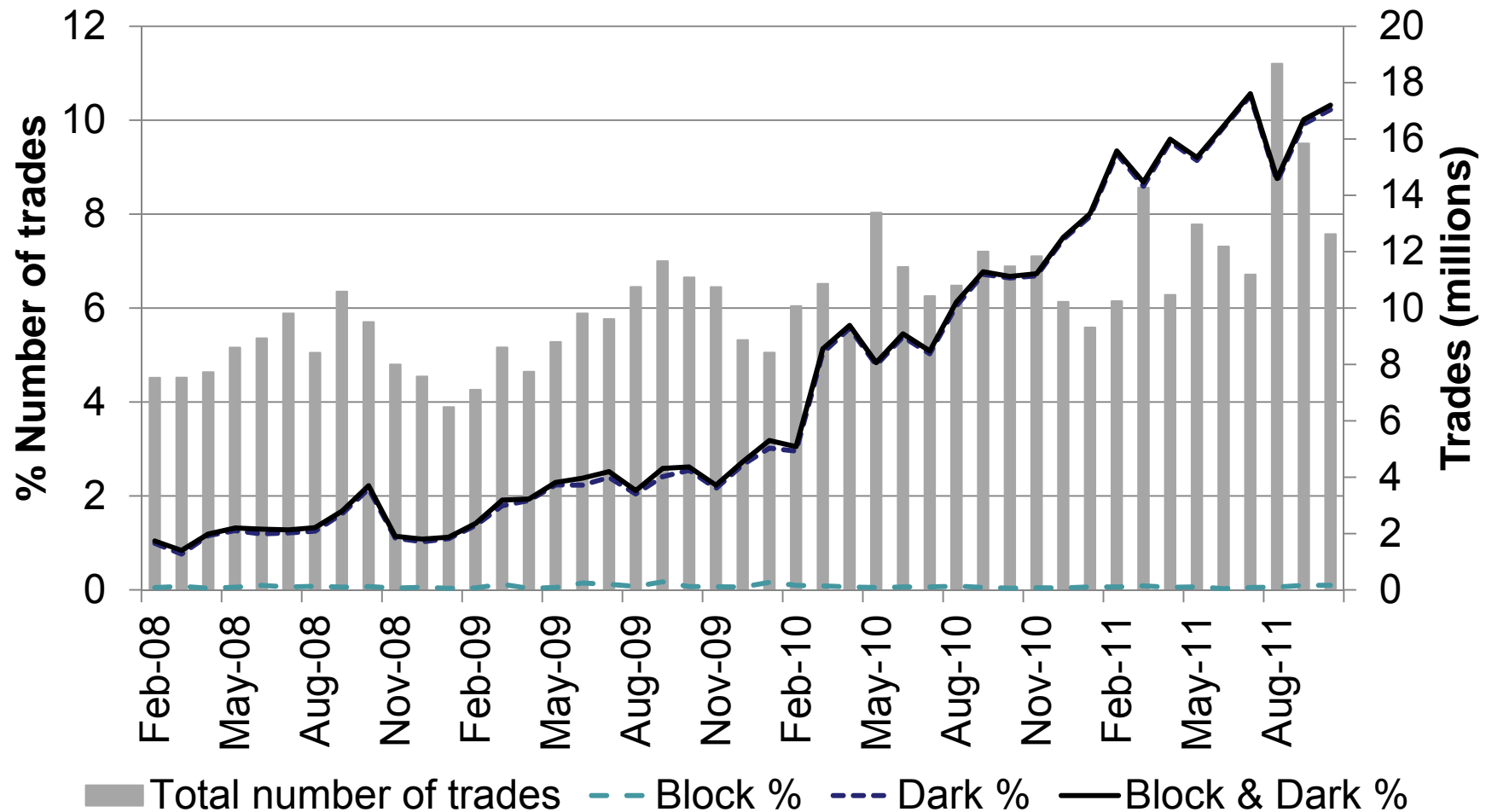
3 crossing syst. exist
(UBS, Citi, CreditSuisse)
Liquidnet enters

11 other crossing
syst. commence
during sample

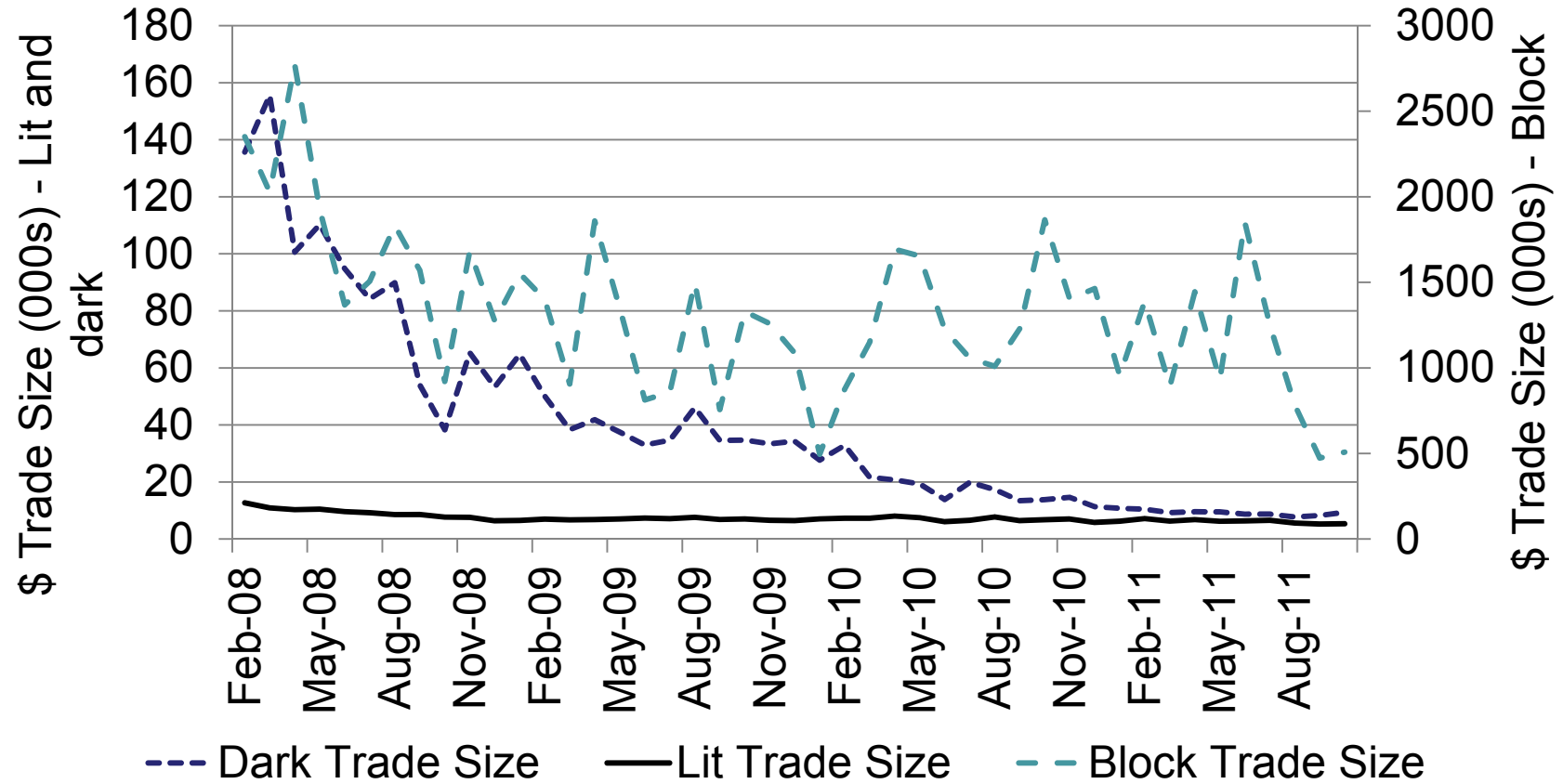
ASX Centre
Point
commences

Chi-X enters
and fragments
lit liquidity

Dark trading in Australia – trade frequency



Average trade sizes



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 Centreport, 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

	Mean	Median
PriceImpactLIT (bps/\$10,000)	3.62	1.91
PriceImpactDARK (bps/\$10,000)	3.31	0.03
PriceImpactBLOCK (bps/\$10,000)	0.15	0.01

Do we observe wider spreads?

	Spread	Spread	Spread
DARK	0.006 (11.05) ^{***}	0.020 (10.23) ^{***}	0.020 (9.75) ^{***}
BLOCK	0.004 (7.52) ^{***}	-0.006 (-1.3)	-0.004 (-1.53)
Controls	All	All	All
R ²	0.74	0.75	0.75
Estimation method	OLS	2SLS	2SLS
Fixed effects	None	None	None
Instruments	None	Set 1	Set 2

- ↑ 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):

$$\text{VarianceRatio}_{kl} = \left| \frac{\sigma_{kl}^2}{k\sigma_l^2} - 1 \right|$$

- 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:

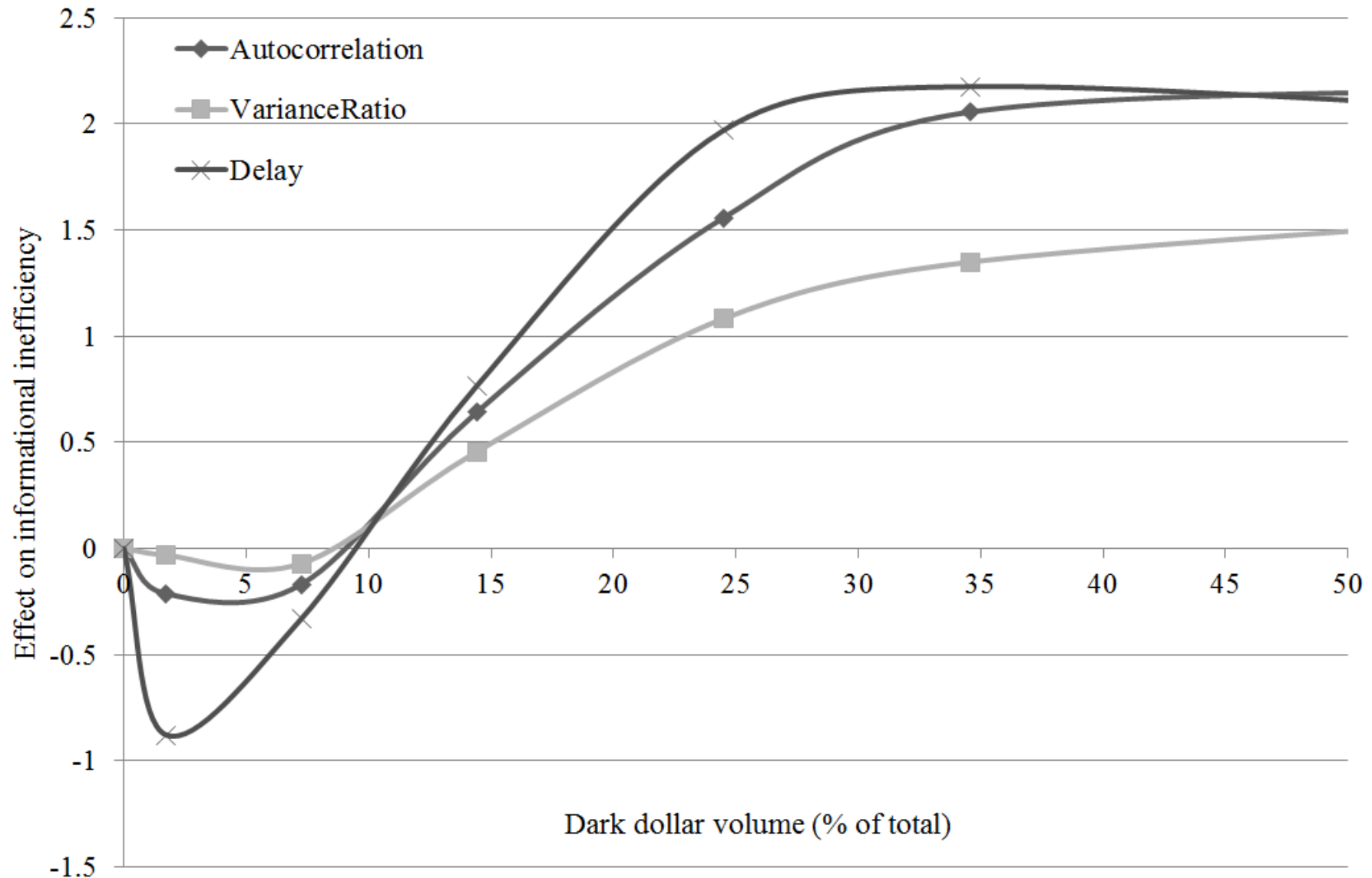
$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \sum_{k=1}^{10} \delta_{i,k} r_{m,t-k} + \varepsilon_{it} \quad \text{Inefficiency}_{\text{Delay}} = 100 \left(1 - \frac{R_{\text{Constrained}}^2}{R_{\text{Unconstrained}}^2} \right)$$

Aggregate informational efficiency

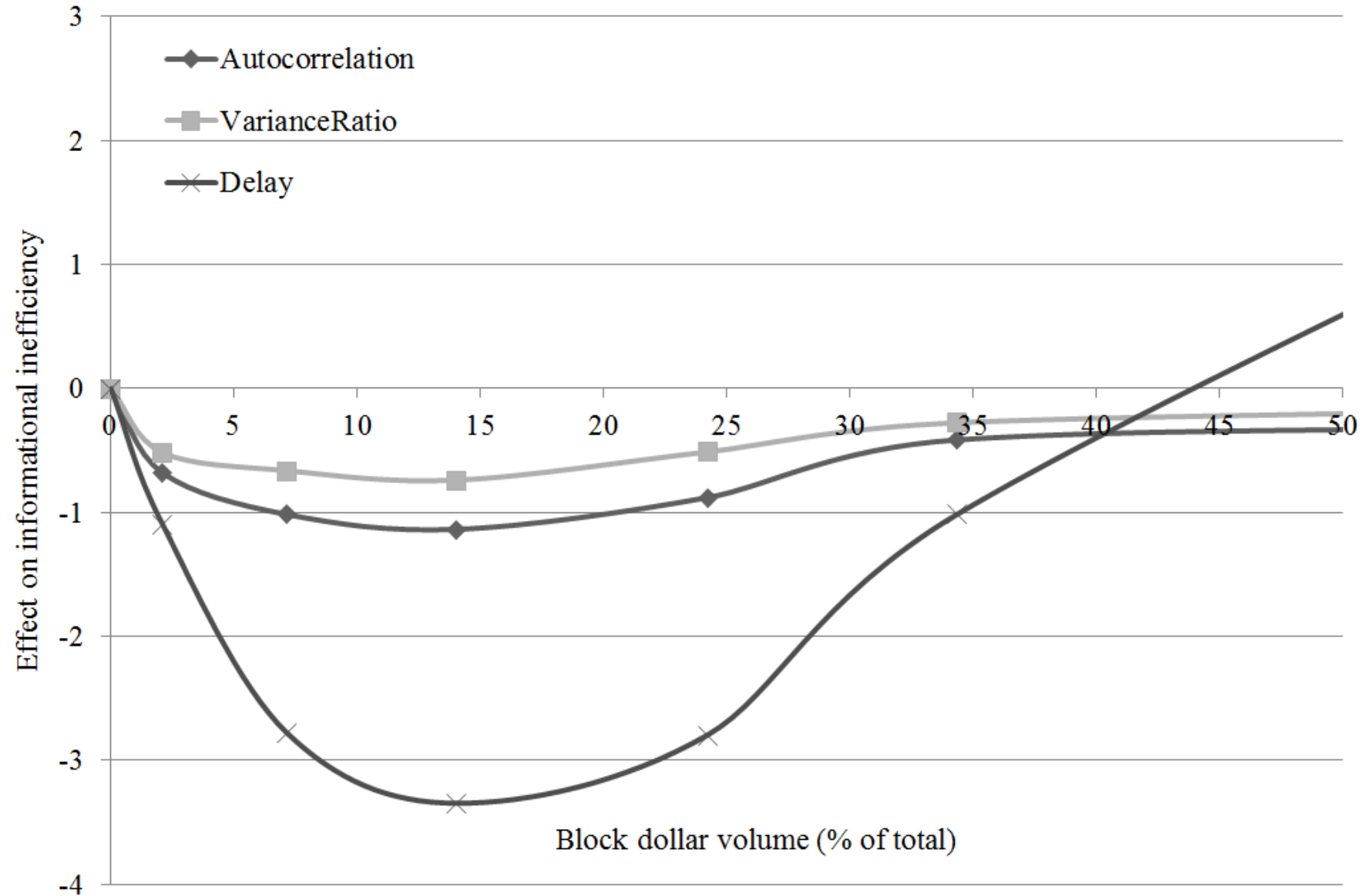
	<i>Autocorrelation</i> _{Factor}	<i>VarianceRatio</i> _{Factor}	<i>Delay</i>
DARK	0.042 (16.84) ^{***}	0.029 (17.75) ^{***}	0.048 (8.72) ^{***}
BLOCK	-0.013 (-5.15) ^{***}	-0.006 (-3.55) ^{***}	-0.002 (-0.26)
Control	All	All	All
R ²	0.06	0.10	0.17
Fixed effects	None	None	None

1. Increasing share of dark trading → 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?



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