The Effect of Fragmentation in Trading on Market Quality in the UK Equity Market

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Motivation

	BATS	Market	% of Mkt	Breakdown
FTSE 100	€889,182,377	€3,455,419,995	25.73%	
CAC 40	€708,725,326	€3,191,382,128	22.21%	
DAX	€711,424,895	€3,023,343,945	23.53%	
FTSE MIB	€363,370,939	€2,435,319,496	14.92%	
IBEX 35	€232,540,490	€1,511,767,523	15.38%	
SMI	€303,883,228	€1,428,822,998	21.27%	
CHERI Nordic	€292,339,071	€1,195,727,382	24.45%	
AEX	€216,393,111	€1,098,005,711	19.71%	
OMXS30	€258,454,677	€1,079,182,566	23.95%	
FTSE 250	€154,538,448	€754,827,260	20.47%	

- The implementation of MiFID in 2007 created a competitive environment for equity trading in Europe
- in July 2014, the volume of the FTSE 100 stocks traded via the London Stock Exchange had declined to about 54%

This paper

- What are the effects of fragmentation in equity markets on the quality of trading outcomes in the UK?
- To answer this question, we extend the common correlated effects estimator (Pesaran, 2006) to quantile regression
  - Control for unobserved common factors such as HFT
  - Characterize the whole conditional distribution
  - Robust to outliers in the dependent variable

Main findings

- Fragmentation in visible order books lowers trading volumes at the LSE but dark trading increases LSE and overall volumes
- Visible fragmentation and dark trading lower volatility
- Dark trading increases the variability of volatility and trading volumes
- Visible fragmentation reduces the variability of volatility
- The level of optimal fragmentation varies across individual firms and is positively related to market capitalization

Related Literature: Fragmentation in equity markets

- Theoretical
  - Why competition can harm market quality (Pagano, 1989)
    - Security exchanges can be natural monopolies
    - A single, consolidated exchange market creates network externalities (but: SORT)
  - Why competition can improve market quality (Biais et. al., 2000)
    - Higher competition generally promotes technological innovation, improves effiency and reduces fees
- Empirical
  - Europe: Gresse (2011), De Jong et al. (2012)
  - US: O'Hara and Ye (2011), Boehmer and Boehmer (2003)

Related Literature: Quantile regression in heterogeneous panels

- Estimation in linear heterogeneous panels with unobserved common factors: Pesaran (2006)
- Quasi-ML estimator for homogeneous, dynamic panels with unobserved common factors: Moon and Weidner (2010)
- Panel quantile regression: Koenker (2004), Lamarche (2010)
- Quantile estimation in homogeneous panels with unobserved common factors and endogeneity: Harding and Lamarche (2013)
- Bias-corrected quantile panel estimators with endogeneous regressors: Arellano and Weidner (2014)
- A semiparametric estimator for large heterogeneous panels: Körber, Linton and Vogt (2013)

Outline

The fast speed of innovation in the financial industry called for a new regulation to replace the Investment Services Directive of 1993

A new structure for equity markets in Europe

- Since 2007, MiFID provides a common regulatory framework for security markets across the EEA
- MiFID abolished the concentration rule in the EEA and created a competitive environment for equity trading
- New types of trading venues that are known as Multilateral Trading Facilities (MTF) or Systematic Internalizers (SI) were created

... for the level of market quality (1)

- We observe a sample of panel data $\{Y_{it}, X_{it}, Z_{it}, d_t\}_{i=1,...N;t=1,..T}$
- We assume that the data come from the model

$$Y_{it} = \alpha_i + \beta_{1i} X_{it} + \beta_{2i} X_{it}^2 + \beta_{3i}^{\intercal} Z_{it} + \delta_i^{\intercal} d_t + \kappa_i^{\intercal} f_t + \varepsilon_{it}$$

- $Q_\tau(\varepsilon_{it} | X_{it}, Z_{it}, d_t, f_t) = 0$ but ε_{it} is allowed to be serially correlated or weakly cross-sectionally correlated

... for the level of market quality (2)

- The regressors $W_{it} = (X_{it}, Z_{it}^{\intercal})^{\intercal}$ are assumed to have the factor structure (Pesaran, 2006)

$$W_{it} = a_i + D_i d_t + K_i f_t + u_{it}$$

- $E(u_{it}) = 0$ but u_{it} is also allowed to be serially correlated or weakly cross-sectionally correlated
- The individual parameters follow the random coefficient specification

$$\beta_i = \beta + v_i, \quad v_i \sim IID(0, \Sigma_v)$$

... for the variability of market quality

- Regulators aim at constructing a robust market structure that contributes to a resilient functioning of equity markets
- We assume the conditional variance of market quality can be modelled by the conditional variance specification

$$Var(Y_{it}|X_{it}, Z_{it}, d_t, f_t) = \alpha_i + \beta_{1i} X_{it} + \beta_{2i} X_{it}^2 + \beta_{3i}^\intercal Z_{it} + \delta_i^\intercal d_t + \kappa_i^\intercal f_t$$

- Or by the conditional IQR

$$q_{0.75}(Y_{it}|X_{it}, Z_{it}, d_t, f_t) - q_{0.25}(Y_{it}|X_{it}, Z_{it}, d_t, f_t) = \alpha_i + \beta_{1i} X_{it} + \beta_{2i} X_{it}^2 + \beta_{3i}^\intercal Z_{it} + \delta_i^\intercal d_t + \kappa_i^\intercal f_t$$

Individual coefficients β_i

- Taking cross-sectional averages of the factor model for regressors,

$$\overline{W}_t = \bar{a} + \overline{D} d_t + \overline{K} f_t + O_p(n^{-1/2})$$

$\longrightarrow$ Unknown factors f_t can be approximated by d_t and $\overline{W_t}$

- β_i can be consistently estimated by the quantile regression in the regression model

$$Y_{it} = \pi_i + \beta_{1i} X_{it} + \beta_{2i} X_{it}^2 + \beta_{3i} Z_{it} + \gamma_i^\intercal d_t + \xi_i^\intercal \overline{W}_t + \epsilon_{it}$$

- $\widehat{\beta}_i$ minimize the objective functions

$$\widehat{Q}_{i\tau T}(\theta) = \sum_{t=1}^{T} \rho_\alpha(Y_{it} - \pi_i - \beta_1 X_{it} - \beta_2 X_{it}^2 - \beta_3^\intercal Z_{it} - \gamma^\intercal d_t - \xi^\intercal \overline{W}_t),$$

where $\rho_\tau(x) = x(\tau - 1(x < 0))$ (Koenker, 2005)

Asymptotic theory for $\widehat{\beta}_i$ (sketch)

- We interpret $\overline{W}_t$ as a preliminary estimator of the function $h_{0t} = \delta + \rho f_t$
- By Theorems 1 and 2 in Chen, Linton and van Keilegrom (2003), $\widehat{\beta}_i$ are consistent and asymptotically normal
- Important condition: $\overline{W}_t$ is uniformly consistent: $\sup_t \|\overline{W}_t - h_{0t}\| = o_p(1)$

Quantile CCE mean group estimator

- The quantile common correlated effects (CCE) mean group estimator is defined as

$$\widehat{\beta} = n^{-1} \sum_{i=1}^{n} \widehat{\beta}_i$$

- Under suitable regularity conditions,

$$\sqrt{n}(\widehat{\beta} - \beta) \Longrightarrow N(0, \Sigma)$$

where the covariance matrix Σ can be estimated by (Pesaran, 2006)

$$\widehat{\Sigma} = \frac{1}{n-1} \sum_{i=1}^{n} (\widehat{\beta}_i - \widehat{\beta})(\widehat{\beta}_i - \widehat{\beta})^\intercal$$

Parameter of interest

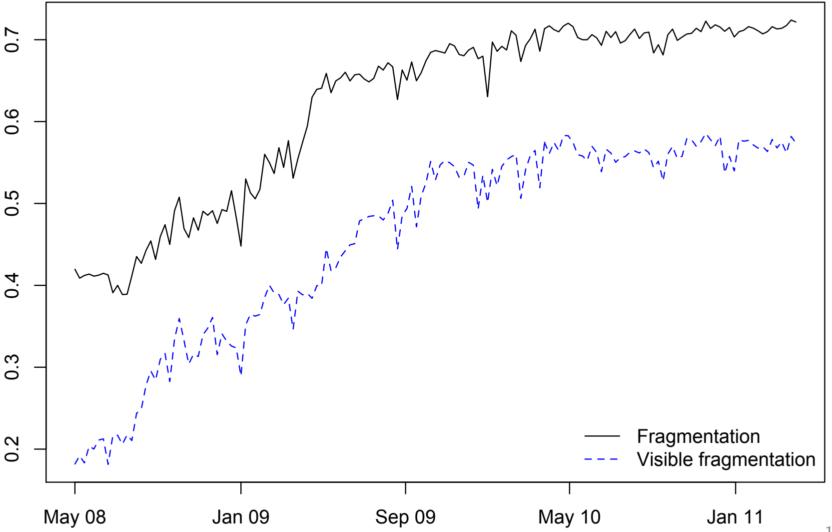
- What is the difference of market quality (the variability of market quality) between a high (H) and low (L) degree of fragmentation or dark trading?

$$\Delta_X = \frac{E_{X=H}Y - E_{X=L}Y}{H-L} = \beta_1 + \beta_2 \frac{(H^2 - L^2)}{H-L} = \beta_1 + \beta_2(H+L)$$

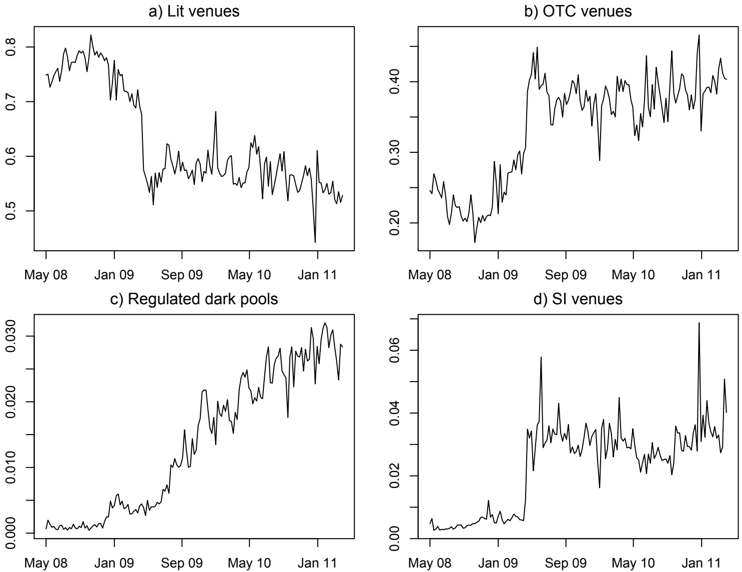
Overview

- FTSE 100 and 250 stocks
- Sample period: 2008-2011
- Weekly frequency
- Fragmentation is measured by $1 -$ Herfindahl Index
- Dark trading is measured by fraction of shares traded on regulated dark pools, OTC venues and systematic internalizers
- Market quality is measured by
    - (Rogers-Saatchel) volatility at the LSE
    - Temporary volatility at the LSE
    - Bid-ask spreads at the LSE
    - Trading volume at the LSE
    - Overall trading volume

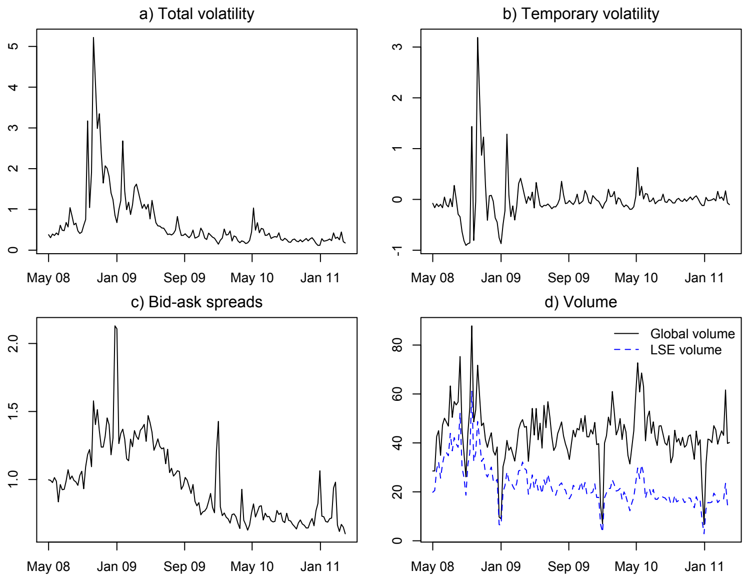
Fragmentation



Share of volume traded by category



Market quality



Regression specifications

$$Y_{it} = \alpha_i + \beta_{1i} X_{it} + \beta_{2i} X_{it}^2 + \beta_{3i} Z_{it} + \delta_{1i}^{\intercal} d_t + \kappa_i^{\intercal} \overline{W}_t + \epsilon_{it}$$

$$Var(Y_{it}|X_{it}, Z_{it}, d_t, f_t) = a_i + b_{1i} X_{it} + b_{2i} X_{it}^2 + b_{3i} Z_{it} + d_{1i}^{\intercal} d_t + k_i^{\intercal} \overline{W}_t$$

where $Var(.)$ is replaced by the squared residuals from the median regression and

- Y_{it} is a measure of the level or variability of market quality
- $X_{it} = (\text{VisFrag}_{it}, \text{Dark}_{it})^{\intercal}$
- $Z_{it} = \log \text{MarketCap}_{it}$
- $\overline{W}_t = (\overline{X}_t, \overline{Z}_t)^{\intercal}$
- $d_t = (\log \text{VIX}_t, \text{FTSEreturn}_{t-1}, \text{Christmas}_t)^{\intercal}$

The effect of visible fragmentation and dark trading on the level of market quality

	Total volatility	Temp. volatility	BA spreads	Global volume	LSE volume
$\Delta_{Vis.frag.}(0.25)$	0.01	-0.263	0.081	-0.034	-0.917
	(0.09)	(-2.879)	(0.959)	(-0.41)	(-11.698)
$\Delta_{Vis.frag.}(0.5)$	-0.181	-0.342	0.139	-0.157	-0.988
	(-1.523)	(-3.537)	(1.86)	(-1.85)	(-11.891)
$\Delta_{Vis.frag.}(0.75)$	-0.487	-0.61	0.112	-0.22	-1.094
	(-3.483)	(-5.432)	(1.309)	(-2.036)	(-10.128)
$\Delta_{Dark}(0.25)$	-0.286	-0.463	-0.004	2.022	0.986
	(-3.735)	(-6.63)	(-0.07)	(32.67)	(16.361)
$\Delta_{Dark}(0.5)$	-0.171	-0.315	-0.035	2.055	1.217
	(-2.518)	(-5.446)	(-0.689)	(34.419)	(20.626)
$\Delta_{Dark}(0.75)$	-0.005	-0.064	0.048	2.072	1.374
	(-0.061)	(-0.935)	(0.785)	(29.979)	(19.166)

Notes: t-statistics are shown in parenthesis. $\Delta_X^T(\tau) = \widehat{\beta}_1(\tau) + \widehat{\beta}_2(\tau)(H + L)$ where $\widehat{\beta}_k$ is the average of individual quantile coefficients

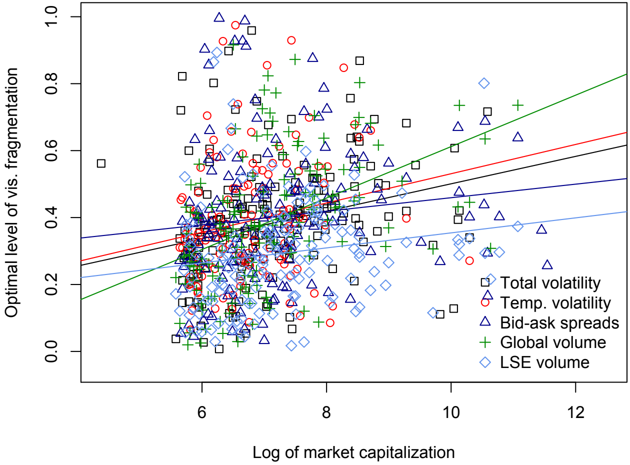
The effect of visible fragmentation and dark trading on the variability of market quality

	Total volatility	Temp. volatility	BA spreads	Global volume	LSE volume
$\Delta_{Vis.frag.}(0.25)$	0.052	-0.007	0.007	0.009	0.019
	(1.701)	(-0.224)	(0.387)	(1.273)	(2.095)
$\Delta_{Vis.frag.}(0.5)$	-0.055	-0.073	0.017	0.017	0.032
	(-1.359)	(-1.231)	(0.636)	(1.213)	(1.403)
$\Delta_{Vis.frag.}(0.75)$	-0.614	-0.244	0.201	-0.169	-0.162
	(-3.145)	(-1.955)	(1.566)	(-1.324)	(-1.228)
$\Delta_{Dark}(0.25)$	0.03	0.022	0.011	0.013	0.024
	(1.771)	(1.853)	(1.211)	(1.966)	(2.599)
$\Delta_{Dark}(0.5)$	0.098	0.055	-0.001	-0.024	0.012
	(3.554)	(2.49)	(-0.064)	(-0.853)	(0.619)
$\Delta_{Dark}(0.75)$	0.19	0.223	0.028	-0.07	-0.046
	(2.054)	(2.66)	(0.387)	(-1.667)	(-0.687)

Notes: t-statistics are shown in parenthesis. $\Delta_X^T(\tau) = \widehat{\beta}_1(\tau) + \widehat{\beta}_2(\tau)(H + L)$ where $\widehat{\beta}_k$ is the average of individual quantile coefficients. Variability is measured by the conditional variance.

Turning points and market capitalization

"... there may be a point at which too much visible fragmentation leads to deteriorating market quality, and this turning point may vary depending on the market capitalization of a stock" (SEC, 2013, p.9)



Conclusions

- This paper develops a quantile CCE estimator for heterogeneous panels
- The estimator is applied to investigate the effects of fragmentation in equity markets on the quality of trading outcomes in the UK