Information Flow Between Spot and Futures Market - The Role of Algorithmic Traders

Anirban Banerjee [1]   Ashok Banerjee [2]

[1]Assistant Professor, Finance, Accounting & Control Department, Indian Institute of Management Kozhikode

[2]Professor, Finance & Control Department, Indian Institute of Management Calcutta

February 8, 2020

Motivation

- Information flow from futures to spot market is well established.

- Primarily due to investors with private information choosing one market over other.

- Benefit of leverage and lower margin requirements make futures market ideal venue.

- Is it true for Indian market? What is the extent of this lead-lag relationship?

- Do algo traders play any role in the information flow?

Rather than using co-movement of return series to deduce about lead-lag relationship, we use order imbalance (Chordia et.al. 2004) to infer the direction of information flow.

Literature Review

- Empirical evidence suggests futures market returns lead cash/spot market returns (weak evidence towards the reverse).

- Kawaller et al. (1987) report that the S&P 500 futures lead the cash market by 20-45 minutes, while the lead from cash to futures is rarely more than a minute.

- Stoll and Whaley (1990) show that the S&P 500 and Major Market Index (MMI) futures lead the spot by 5-10 minutes, while the feedback is of much shorter duration.

Literature Review [Contd.]

- Chan (1992) reports that futures market leads the spot to a greater degree in presence of market-wide information.

$$R_{s,t} = a + \sum_{k=-p}^{p} b_k R_{F,t+k} + \epsilon_{s,t} \qquad (1)$$

- Contemporaneous and bi-directional lead-lag relationship between the spot and futures markets in the Indian context (Mukherjee et al. 2006, Mallikarjunappa et al. 2010).

Literature Review [Contd.]

- Empirical relationship of order imbalance and individual stock returns (Cushing & Madhavan, 2000; Stoll, 2000) and more specifically into institutional order imbalances (Lakonishok, Shleifer, & Vishny, 1992; Kraus & Stoll, 1972; Sias, 1997; Wermers, 1999).

- Chordia, Roll, and Subrahmanyam (2002) and Chordia and Subrahmanyam (2004) show that the relationship holds for NYSE stocks in longer term (1988-1998) both for index returns and individual stock returns.

- Similar results were obtained from inspection of order-driven markets (Handa, Schwartz, & Tiwari, 2003; Y. C. Huang & Chou, 2007).

Algorithmic Trading

- Trading orders automatically generated from computer terminals without any real-time manual intervention.

- Algorithmic traders presently provide bulk of the trading volume in stock exchanges around the globe - both in developed and developing markets.

- In Indian derivative market, algorithmic traders contribute almost 45% of the trading volume.

- Role of algorithmic traders is far from clear (especially HFTs).

Algorithmic Trading [Contd.]

Figure: Growth of Algorithmic Trading Over the Years
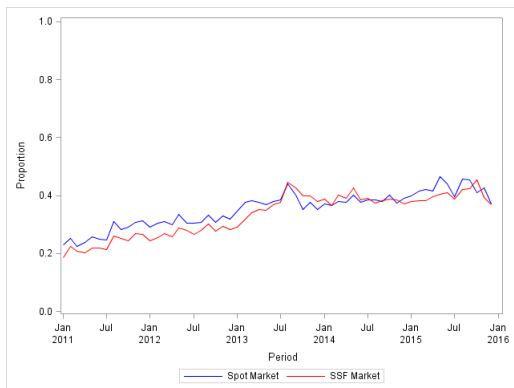
Algorithmic Trading [Contd.]

Table: Proportions of trading volume contributed by different category of algorithmic and non-algorithmic traders in the NSE spot and equity derivatives segment (for the period Jan-Dec 2015)

	Custodian	Proprietary	NCNP	Total
Spot Market				
Algo	21.34%	13.18%	7.76%	42.28%
Non-Algo	11.40%	7.45%	38.87%	57.72%
Stock Futures				
Algo	12.08%	17.20%	10.76%	40.04%
Non-Algo	10.47%	12.75%	36.74%	59.96%

Data

- Dataset - Sample set consists of all 160 NSE stocks traded in the futures market during Jan-Jun 2015.

- These are the stocks with highest liquidity and largest market capitalization.

- The average market capitalization of these 160 stocks is 467 Billion INR (7.05 Billion USD) and median market capitalization being 208 Billion INR (3.14 Billion USD)

- We only consider near-month contracts for this analysis (for the sake of liquidity).

- We classify all trades as buyer-initiated or seller-initiated. Using the NSE dataset gives us the unique benefit of having the entire sequence of order messages received by the exchange.

Data

Table: Month-wise turnover (in INR billion) and number of trades in the NSE spot and stock futures market during 2015.

Month- Year	Companies listed	Spot Market No. of trades (million)	Turnover (INR billion)	Stock Futures Contracts traded (million)	Turnover (INR billion)
Jan-15	1,718	161	3,839	23	7,147
Feb-15	1,719	158	3,927	23	7,266
Mar-15	1,733	161	3,979	22	6,986
Apr-15	1,740	151	3,793	22	6,764
May-15	1,750	145	3,619	24	6,285
Jun-15	1,751	153	3,333	24	6,123
Jul-15	1,756	174	3,835	26	7,199
Aug-15	1,772	186	4,199	27	7,349
Sep-15	1,779	150	3,284	22	5,703
Oct-15	1,781	146	3,338	21	6,277
Nov-15	1,786	132	3,072	12	5,976
Dec-15	1,794	148	3,350	12	6,305

Figure: Daily traded volume (INR) in NSE single stock futures market segregated according to contract expiries
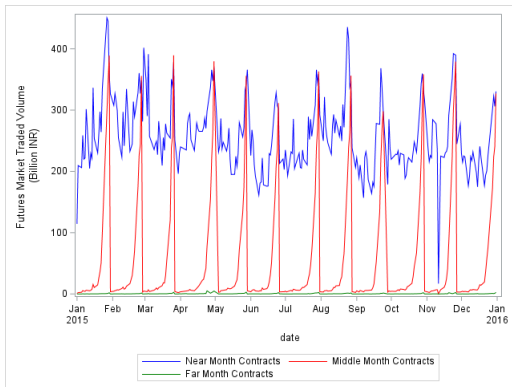
Measure of Order Imbalance

- Measure of Order Imbalance provided by Chordia et. al. (2004).

- *OIBNUM* : number of buyer-initiated minus the number of seller-initiated trades scaled by the total number of trades over a period.

- *OIBVOL* : INR volume of buyer-initiated minus the INR volume of seller-initiated trades scaled by the total INR volume of trades over a period.

Summary Statistics

Table: The table presents the summary statistics for the NSE stocks traded in the futures market during Jan-Jun 2015. Number of stocks included in the sample is 160.

Variable	5 Min Interval		1 Min Interval	
	Mean	Std. Dev.	Mean	Std. Dev.
CM_OIBNUM	-0.0186	0.3688	-0.0115	0.4951
CM_OIBVOL	-0.0151	0.3911	-0.0088	0.5499
CM_OIBNUM (Unscaled)	-5.3854	243.4568	-1.0079	69.7841
CM_OIBVOL (Unscaled) (INR million)	-1.3320	21.2451	-0.0506	36.2470
FUT_OIBNUM	-0.0371	0.4017	-0.0305	0.5525
FUT_OIBVOL	-0.0431	0.4198	-0.0328	0.5639
FUT_OIBNUM (Unscaled)	-2.2609	33.3387	-0.5203	11.1568
FUT_OIBVOL (Unscaled) (INR million)	-1.3320	18.0152	-0.3044	6.6334
Spot Trade Count	410.3087	577.8125	86.3000	136.7881
Spot Trade Volume (INR million)	11.5594	36.1484	2.4887	38.6544
Futures Trade Count	62.8276	124.5347	15.6600	32.9394
Futures Trade Volume (INR million)	24.2399	53.8856	6.0117	14.6809
Spot Return ($\times 10^4$)	-0.2834	24.3463	-0.0682	18.0121
Futures Return ($\times 10^4$)	-0.2720	25.4459	-0.0325	54.0708
Index Return ($\times 10^4$)	-0.1141	8.7042	-0.0527	4.2304
Excess Spot Return ($\times 10^4$)	-0.1693	22.7030	-0.0180	17.6726
Excess Futures Return ($\times 10^4$)	-0.1477	23.4507	0.0343	54.1141

Anirban Banerjee · IIM Kozhikode

Information Flow Between Spot and Futures Market - The Role of Algorithmic Traders

Correlation Check

Table: Cross-sectional average of individual time-series correlations for order imbalance measures computed at 5 min and 1 min interval.

Panel A : 5 Min Interval

	CM_OIBVOL	FUT_OIBNUM	FUT_OIBVOL	Excess Spot Returns
CM_OIBNUM	0.7196	0.2620	0.2363	0.2540
CM_OIBVOL	1.0000	0.3080	0.2799	0.2670
FUT_OIBNUM		1.0000	0.9566	0.2724
FUT_OIBVOL			1.0000	0.2527

Panel B : 1 Min Interval

	CM_OIBVOL	FUT_OIBNUM	FUT_OIBVOL	Excess Spot Returns
CM_OIBNUM	0.7832	0.2570	0.2465	0.2976
CM_OIBVOL	1.0000	0.2727	0.2614	0.2914
FUT_OIBNUM		1.0000	0.9826	0.2337
FUT_OIBVOL			1.0000	0.2256

CM_OIBNUM - Spot market order imb. in number of transactions scaled by total trans.
CM_OIBVOL - Spot market order imb. in INR scaled by total INR volume
FUT_OIBNUM - Fut. market order imb. in number of transactions scaled by total trans.
FUT_OIBVOL - Futures market order imb. in INR scaled by total INR volume

Order Imbalance and Intraday Returns

Hypothesis

Informed traders utilize their directional information first in the futures market, resulting in order imbalance in the futures market which is positively related to future spot returns.

$$R_{it} - R_{mt} = a + \sum_{k=0}^{5} b_k CM\_OIB_{i,t-k} + \delta_i + e_{it} \qquad (2)$$

$$R_{it} - R_{mt} = a + \sum_{k=0}^{5} b_k CM\_OIB_{i,t-k} + \sum_{k=0}^{5} c_k FUT\_OIB_{i,t-k} + \delta_i + e_{it} \qquad (3)$$

Information Flow from Futures to Spot Market

Table: Panel Data Regressions of 5 min interval cash market excess returns on contemporaneous and lagged order imbalances of the cash and futures market.

Dependent Variable: Excess Spot Returns				
	(1)		(2)	
Variable	Estimate	t Stat	Estimate	t Stat
Panel A : OIBNUM				
Constant	-0.071***	(-11.93)	0.198***	(13.50)
CM_OIBNUM	24.670***	(27.89)	20.770***	(27.99)
L1_CM_OIBNUM	-9.565***	(-22.14)	-8.798***	(-21.59)
L2_CM_OIBNUM	-3.674***	(-22.88)	-3.077***	(-21.28)
L3_CM_OIBNUM	-2.604***	(-18.63)	-2.044***	(-16.26)
L4_CM_OIBNUM	-2.321***	(-17.32)	-1.799***	(-15.46)
L5_CM_OIBNUM	-2.310***	(-15.66)	-1.791***	(-13.57)
FUT_OIBNUM			10.140***	(30.55)
L1_FUT_OIBNUM			-0.478***	(-3.80)
L2_FUT_OIBNUM			-0.424***	(-6.16)
L3_FUT_OIBNUM			-0.539***	(-8.06)
L4_FUT_OIBNUM			-0.473***	(-8.05)
L5_FUT_OIBNUM			-0.440***	(-7.66)
No. of obs.		1,353,730		1,353,730

Information Flow from Futures to Spot Market

Table: Panel Data Regressions of 1 min interval cash market excess returns on contemporaneous and lagged order imbalances of the cash and futures market.

Dependent Variable: Excess Spot Returns				
	(1)		**(2)**	
Variable	**Estimate**	**t Stat**	**Estimate**	**t Stat**
Panel A : OIBNUM				
Constant	0.001	(0.77)	0.094***	(25.56)
CM_OIBNUM	8.983***	(28.31)	8.078***	(26.51)
L1_CM_OIBNUM	-3.354***	(-13.68)	-3.397***	(-13.42)
L2_CM_OIBNUM	-0.991***	(-24.49)	-0.888***	(-24.69)
L3_CM_OIBNUM	-0.808***	(-24.35)	-0.689***	(-23.27)
L4_CM_OIBNUM	-0.752***	(-26.32)	-0.629***	(-25.06)
L5_CM_OIBNUM	-0.765***	(-25.79)	-0.640***	(-24.14)
FUT_OIBNUM			3.284***	(38.41)
L1_FUT_OIBNUM			0.318***	(7.18)
L2_FUT_OIBNUM			-0.084***	(-6.28)
L3_FUT_OIBNUM			-0.122***	(-9.31)
L4_FUT_OIBNUM			-0.102***	(-9.72)
L5_FUT_OIBNUM			-0.126***	(-12.02)
No. of Obs.		7,085,452		7,085,452

Information Flow from Futures to Spot Market

Table: Panel Data Regressions of 1 min interval cash market excess returns on contemporaneous and lagged order imbalances of the cash and futures market on a monthly basis from Jan-2015 to Jun-2015.

Dependent Variable: Excess Spot Returns						
Variable	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15
Constant	–0.012***	0.255***	0.147***	0.059***	0.057***	0.031***
CM_OIBNUM	7.627***	8.731***	7.572***	8.549***	7.951***	8.344***
L1_CM_OIBNUM	–3.066***	–3.246***	–3.366***	–3.334***	–3.398***	–3.576***
L2_CM_OIBNUM	–0.741***	–0.874***	–0.969***	–0.847***	–0.790***	–0.820***
L3_CM_OIBNUM	–0.552***	–0.663***	–0.862***	–0.679***	–0.515***	–0.607***
L4_CM_OIBNUM	–0.564***	–0.533***	–0.745***	–0.588***	–0.480***	–0.568***
L5_CM_OIBNUM	–0.512***	–0.623***	–0.761***	–0.605***	–0.492***	–0.522***
FUT_OIBNUM	2.907***	3.603***	3.171***	3.351***	3.256***	3.477***
L1_FUT_OIBNUM	0.294***	0.188***	0.202***	0.405***	0.347***	0.479***
L2_FUT_OIBNUM	0.0442*	–0.188***	–0.179***	–0.0202	–0.0726**	–0.0672
L3_FUT_OIBNUM	–0.0616***	–0.222***	–0.211***	–0.0342	–0.101***	–0.0772*
L4_FUT_OIBNUM	–0.0413*	–0.241***	–0.186***	–0.0280	–0.0390	–0.0578
L5_FUT_OIBNUM	–0.036*	–0.262***	–0.224***	–0.044*	–0.083***	–0.083**
No. of obs.	1,223,628	1,163,623	1,222,540	1,101,492	1,155,387	1,219,428

Test for Unidirectional Information Flow

Table: Panel Data Regressions of 1 min interval futures market excess returns on contemporaneous and lagged order imbalances of the cash and futures market.

Dependent Variable: Excess Futures Returns				
	(1)		**(2)**	
Variable	**Estimate**	**t Stat**	**Estimate**	**t Stat**
Panel A : OIBNUM				
Constant	0.148***	(31.28)	0.164***	(30.90)
CM_OIBNUM			6.535***	(29.94)
L1_CM_OIBNUM			-0.485***	(-5.39)
L2_CM_OIBNUM			-0.985***	(-19.28)
L3_CM_OIBNUM			-0.841***	(-16.98)
L4_CM_OIBNUM			-0.829***	(-14.06)
L5_CM_OIBNUM			-0.895***	(-20.92)
FUT_OIBNUM	6.248***	(29.41)	5.031***	(26.85)
L1_FUT_OIBNUM	-0.656***	(-5.52)	-0.763***	(-6.24)
L2_FUT_OIBNUM	-0.536***	(-12.56)	-0.355***	(-8.40)
L3_FUT_OIBNUM	-0.520***	(-17.30)	-0.311***	(-10.64)
L4_FUT_OIBNUM	-0.353***	(-11.76)	-0.125***	(-3.93)
L5_FUT_OIBNUM	-0.487***	(-17.32)	-0.245***	(-8.81)
No. of Obs.		5,608,792		5,608,792

Categories of Algorithmic Traders

- Algorithmic traders are not homogeneous in terms of motivation.
- HFTs (proxied by Prop Algo Traders) are not known to trade on information.
- Agency algorithmic traders trade for others (may be even for informed institutional investors). But they split the orders to minimize price impact. As such, information content of orders placed on behalf of informed investors may not be impacted in the order imbalance.

Hypothesis

Trades executed by both propitiatory and agency algorithmic traders in the stock futures market do not convey private directional information which is related to future spot returns.

Categorized Order Imbalance

Table: Order imbalance split across categories of HFT and non-HFT Traders

Dependent Variable: Excess Spot Returns				
	(Full Sample)	(Full Sample)	(Pos. Extrm. Ret)	(Neg. Extrm. Ret)
Constant	0.152***	0.129***	19.85***	-19.73***
	(32.40)	(31.84)	(291.58)	(-216.97)
CM_OIBNUM (HFT)	6.685***	6.914***	-0.0858	-0.445
	(18.37)	(18.80)	(-0.26)	(-1.33)
CM_OIBNUM (Non-HFT)	5.965***	7.738***	1.363***	0.978***
	(27.58)	(24.17)	(6.42)	(4.93)
FUT_OIBNUM (HFT)	3.122***	2.754***	-3.358***	-2.787***
	(18.92)	(16.74)	(-11.42)	(-9.71)
FUT_OIBNUM (Non-HFT)	3.576***	3.491***	0.755***	0.322*
	(41.91)	(40.70)	(6.47)	(2.17)
L1_CM_OIBNUM (HFT)		-1.639***	0.143	0.169
		(-15.77)	(0.58)	(1.31)
L1_CM_OIBNUM (Non-HFT)		-4.619***	0.731***	0.214*
		(-14.95)	(7.83)	(2.28)
L1_FUT_OIBNUM (HFT)		0.152*	-0.746*	0.117
		(2.23)	(-2.07)	(1.29)
L1_FUT_OIBNUM (Non-HFT)		0.283***	0.654***	0.298***
		(7.64)	(14.11)	(4.74)
No. of Obs.	7,162,806	7,162,806	709,038	706,888

Categorized Order Imbalance

Table: Order imbalance split across categories of algo and non-algo traders.

Dependent Variable: Excess Spot Returns	(Full Sample)	(Full Sample)	(Pos. Extrm. Ret)	(Neg. Extrm. Ret)
Constant	0.148***	0.137***	19.87***	-19.70***
	(30.37)	(32.00)	(317.92)	(-224.43)
CM_OIBNUM (Algo)	5.349***	6.405***	0.414*	0.451*
	(22.64)	(24.52)	(2.18)	(2.12)
CM_OIBNUM (Non-Algo)	6.703***	8.480***	1.556***	0.780**
	(25.55)	(22.04)	(6.32)	(3.16)
FUT_OIBNUM (Algo)	3.058***	2.809***	-2.002***	-1.624***
	(29.67)	(28.25)	(-11.16)	(-8.39)
FUT_OIBNUM (Non-Algo)	3.942***	3.919***	1.959***	1.160***
	(43.24)	(41.57)	(15.59)	(7.04)
L1_CM_OIBNUM (Algo)		-2.837***	0.654***	0.591***
		(-25.47)	(8.05)	(7.29)
L1_CM_OIBNUM (Non-Algo)		-5.314***	0.546***	-0.143
		(-13.29)	(4.99)	(-0.95)
L1_FUT_OIBNUM (Algo)		0.0577	-0.0845	0.108
		(1.49)	(-1.49)	(1.81)
L1_FUT_OIBNUM (Non-Algo)		0.341***	0.665***	0.245**
		(8.77)	(8.93)	(2.76)
No. of Obs.	7,162,806	7,162,806	709,038	706,888

Categorized Order Imbalance

Table: Order imbalance split across all possible categories

Explanatory Variable: Excess Spot Returns	Full Sample		Positive Extremes		Negative Extremes	
L1_FUT_CA_OIBNUM	-0.0902	(-1.96)	0.200	(1.62)	0.248*	(2.40)
L1_FUT_PA_OIBNUM	0.115	(1.70)	-0.773	(-1.90)	0.0813	(0.92)
L1_FUT_NCNPA_OIBNUM	0.0743	(1.49)	-0.0352	(-0.13)	-0.184*	(-2.48)
L1_FUT_CNA_OIBNUM	0.394***	(6.80)	1.665**	(2.97)	0.565***	(4.33)
L1_FUT_PNA_OIBNUM	0.332***	(6.46)	1.034***	(10.45)	0.294***	(3.47)
L1_FUT_NCNPNA_OIBNUM	0.335***	(7.31)	0.519**	(2.94)	0.313**	(2.65)
No. of Obs	7,162,806		709,038		706,888	

Conclusion

- Information in the futures market leads the spot market in the order of one minute.

- Algorithmic traders do not trade on information.

- Information flow from the futures to the spot market is established through non-algorithmic traders.

- Information flow is evident even during of periods of extreme returns in the spot market.

- Segmenting the algorithmic traders into the level of proprietary and agency algorithmic traders do not change the results.

Table: The table defines Order imbalance(OIB) as the estimated buyer-initiated minus seller-initiated INR volume of transactions scaled by total INR volume of trade (OIBVOL) over five minute interval.

Dependent Variable: Excess Returns				
	(1)		**(2)**	
Variable	**Estimate**	**t Stat**	**Estimate**	**t Stat**
Constant	-0.065***	(-12.51)	0.205***	(14.63)
CM_OIBVOL	18.410***	(28.32)	15.320***	(28.98)
L1_CM_OIBVOL	-4.763***	(-24.80)	-4.259***	(-27.06)
L2_CM_OIBVOL	-2.417***	(-22.34)	-2.009***	(-21.67)
L3_CM_OIBVOL	-1.767***	(-19.68)	-1.361***	(-16.68)
L4_CM_OIBVOL	-1.773***	(-21.53)	-1.410***	(-18.79)
L5_CM_OIBVOL	-1.701***	(-19.95)	-1.367***	(-17.54)
FUT_OIBVOL			9.432***	(31.58)
L1_FUT_OIBVOL			-0.939***	(-8.47)
L2_FUT_OIBVOL			-0.538***	(-10.04)
L3_FUT_OIBVOL			-0.529***	(-9.71)
L4_FUT_OIBVOL			-0.386***	(-7.79)
L5_FUT_OIBVOL			-0.373***	(-7.05)
No. of obs.		1,353,730		1,353,730

OIBVOL-1 Min

Table: The table defines Order imbalance(OIB) as the estimated buyer-initiated minus seller-initiated INR volume of transactions scaled by total INR volume of trade (OIBVOL) over one minute interval.

Dependent Variable: Excess Returns				
	(1)		(2)	
Variable	Estimate	t Stat	Estimate	t Stat
Constant	0.000	(0.32)	0.090***	(25.03)
CM_OIBVOL	6.848***	(35.06)	6.079***	(33.85)
L1_CM_OIBVOL	-1.854***	(-17.17)	-1.891***	(-16.74)
L2_CM_OIBVOL	-0.611***	(-22.40)	-0.541***	(-23.33)
L3_CM_OIBVOL	-0.547***	(-25.19)	-0.465***	(-24.20)
L4_CM_OIBVOL	-0.503***	(-26.33)	-0.420***	(-24.84)
L5_CM_OIBVOL	-0.518***	(-27.32)	-0.435***	(-25.49)
FUT_OIBVOL			3.261***	(36.58)
L1_FUT_OIBVOL			0.135***	(3.94)
L2_FUT_OIBVOL			-0.150***	(-12.22)
L3_FUT_OIBVOL			-0.153***	(-12.60)
L4_FUT_OIBVOL			-0.124***	(-12.43)
L5_FUT_OIBVOL			-0.142***	(-14.73)
No. of Obs.		7,085,452		7,085,452

Test for Unidirectional Information Flow [OIBVOL]

Table: The table defines Order imbalance(OIB) as the estimated buyer-initiated minus seller-initiated INR volume of transactions scaled by total INR volume of trade (OIBVOL) over one minute interval.

Dependent Variable: Excess Futures Returns				
	(1)		(2)	
Variable	Estimate	t Stat	Estimate	t Stat
Constant	0.153***	(30.11)	0.156***	(30.67)
CM_OIBVOL			5.184***	(32.90)
L1_CM_OIBVOL			-0.041	(-0.54)
L2_CM_OIBVOL			-0.541***	(-13.27)
L3_CM_OIBVOL			-0.537***	(-15.81)
L4_CM_OIBVOL			-0.529***	(-11.41)
L5_CM_OIBVOL			-0.529***	(-14.74)
FUT_OIBVOL	5.815***	(28.45)	4.734***	(25.35)
L1_FUT_OIBVOL	-0.516***	(-4.70)	-0.668***	(-5.82)
L2_FUT_OIBVOL	-0.498***	(-11.81)	-0.401***	(-8.97)
L3_FUT_OIBVOL	-0.479***	(-16.43)	-0.335***	(-12.04)
L4_FUT_OIBVOL	-0.321***	(-11.06)	-0.157***	(-5.02)
L5_FUT_OIBVOL	-0.449***	(-16.50)	-0.279***	(-9.78)
No. of Obs.		5,608,792		5,608,792

Categorized Order Imbalance [OIBVOL]

Table: Order imbalance split across categories of HFT and non-HFT Traders

Dependent Variable: Excess Spot Returns				
	(Full Sample)	(Full Sample)	(Pos. Extrm.)	(Neg. Extrm.)
Constant	0.130***	0.118***	20.04***	-19.83***
	(32.46)	(31.33)	(208.84)	(-240.56)
CM_OIBVOL (HFT)	5.514***	5.538***	-1.283***	-1.323***
	(22.64)	(22.68)	(-5.45)	(-5.32)
CM_OIBVOL (Non-HFT)	5.281***	5.941***	0.797*	0.847***
	(31.58)	(31.42)	(2.15)	(5.42)
FUT_OIBVOL (HFT)	2.628***	2.459***	-3.743***	-3.397***
	(16.10)	(14.97)	(-12.25)	(-11.58)
FUT_OIBVOL (Non-HFT)	3.409***	3.420***	0.782***	0.291*
	(39.06)	(38.40)	(6.82)	(2.07)
L1_CM_OIBVOL (HFT)		-0.885***	0.503***	0.295**
		(-15.36)	(5.38)	(3.06)
L1_CM_OIBVOL (Non-HFT)		-2.492***	0.909***	0.533***
		(-19.39)	(15.64)	(8.12)
L1_FUT_OIBVOL (HFT)		-0.0788	-0.929**	-0.122
		(-1.32)	(-2.65)	(-1.31)
L1_FUT_OIBVOL (Non-HFT)		0.0697*	0.583***	0.189**
		(2.06)	(13.67)	(3.14)
No. of Obs.	7,162,806	7,162,806	709,038	706,888

Categorized Order Imbalance [OIBVOL]

Table: Order imbalance split across categories of algo and non–algo traders.

Dependent Variable: Excess Spot Returns				
	(Full Sample)	(Full Sample)	(Pos. Extrm.)	(Neg. Extrm.)
Constant	0.135***	0.127***	20.05***	-19.81***
	(33.58)	(34.24)	(205.59)	(-244.36)
CM_OIBVOL (Algo)	4.546***	4.973***	-0.320*	0.000140
	(26.50)	(28.67)	(-2.31)	(0.00)
CM_OIBVOL (Non-Algo)	5.970***	6.547***	0.912	0.663**
	(30.17)	(29.39)	(1.77)	(3.21)
FUT_OIBVOL (Algo)	2.743***	2.659***	-2.141***	-1.835***
	(26.56)	(25.87)	(-12.19)	(-9.88)
FUT_OIBVOL (Non-Algo)	3.792***	3.830***	2.007***	1.158***
	(41.25)	(40.07)	(16.05)	(7.44)
L1_CM_OIBVOL (Algo)		-1.652***	0.666***	0.727***
		(-31.71)	(7.65)	(11.43)
L1_CM_OIBVOL (Non-Algo)		-2.748***	0.962***	0.310**
		(-16.86)	(10.15)	(2.83)
L1_FUT_OIBVOL (Algo)		-0.167***	-0.184**	-0.0338
		(-5.46)	(-3.33)	(-0.61)
L1_FUT_OIBVOL (Non-Algo)		0.157***	0.625***	0.146
		(3.83)	(10.84)	(1.68)
No. of Obs.	7,162,806	7,162,806	709,038	706,888

Categorized Order Imbalance [OIBVOL]

Table: Order imbalance split across all possible categories.

Explanatory Variable: Excess Spot Returns						
	(Full Sample)		(Pos. Extrm.).		(Neg. Extrm.)	
L1_FUT_CA_OIBVOL	-0.308***	(-7.76)	0.0374	(0.31)	0.0792	(0.83)
L1_FUT_PA_OIBVOL	-0.0555	(-0.89)	-0.928*	(-2.22)	-0.136	(-1.49)
L1_FUT_NCNPA_OIBVOL	-0.163***	(-3.96)	-0.146	(-0.57)	-0.340***	(-4.84)
L1_FUT_CNA_OIBVOL	0.259***	(5.05)	1.438**	(2.85)	0.416***	(3.63)
L1_FUT_PNA_OIBVOL	0.190***	(3.57)	0.933***	(9.74)	0.181*	(2.05)
L1_FUT_NCNPNA_OIBVOL	0.122**	(2.75)	0.485**	(3.13)	0.227*	(1.98)
No. of Obs.	7,162,806		709,038		706,888	