Online Appendix to "High-Frequency Trading around Institutional Orders"

This online appendix contains the following list of tables and figures references in the main document (note that to avoid confusion the numbering starts where the numbering of tables and figures in the main text left off).

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Table 7: Mean reversion in cumulative net flow: Flat at the end of the day?

This table reports the ratio of absolute cumulative net flow and volume (i.e., directionality), for both HFTs and for institutional investors. Let B be buy volume (in shares or dollars) and S be sell volume, then this ratio is defined as |B-S|/(B+S). For HFTs the ratio is calculated for stock-days when at least one of the investors in our sample was executing an order, and for *all* stock-days to provide a benchmark. The ratio is further calculated for stock-weeks and stock-months to illustrate to what extent there is mean-reversion across days. For investors, it is calculated for stocks-days, stock-weeks, and stock-months, but only for those where they were executing at least one order.

	Directionality: |B-S|/(B+S)	
	$100,000	#Trades
HFT: Stock-days with institutional investors executing orders	0.078	0.078
HFTs with-wind tercile	0.080	0.080
HFTs neutral tercile	0.076	0.076
HFTs against-wind tercile	0.078	0.078
HFT: All stock-days	0.084	0.081
HFT: All stock-weeks	0.048	0.049
HFT: All stock-months	0.028	0.029
Institutional investors: Stock-days	0.990	0.984
Institutional investors: Stock-weeks	0.914	0.914
Institutional investors: Stock-months	0.833	0.830

Table 8: Do all HFTs follow the same strategy?

This table disaggregates HFT cumulative net flow in the lifetime of an institutional order. It distinguishes between institutional orders where HFTs *collectively* trade against the wind (AW) or with the wind (WW). HFT cumulative net flow is signed positive if it had the same sign as the institutional order and is negative otherwise. Since the size of total cumulative net flow for against-wind orders ($-397,400) is not significantly different from that of with-wind orders ($359,300), it is meaningful to test whether the same is true at the disaggregated level, that is, for all HFTs individually. To that end, the rightmost column tests whether the difference between the WW average and (-1) times the AW average is significantly different from zero. The table further reports the p-value of the joint test on whether this is true for all HFTs simultaneously. The superscripts ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	HFT cumulative net flow (in $1000)			
	Against-wind (AW)	With-wind (WW)	Difference: "WW=(-AW)"[a]	
HFT 1	-67.2	83.3	16.0	***
HFT 2	-1.7	1.5	-0.2	
HFT 3	-44.0	74.5	30.5	***
HFT 4	-1.8	2.8	1.0	
HFT 5	-25.7	39.9	14.2	
HFT 6	-21.3	15.3	-5.9	***
HFT 7	-159.9	73.0	-86.9	
HFT 8	-16.7	20.6	4.0	***
HFT 9	-59.2	48.4	-10.8	
HFT 10	-4.3	9.6	5.3	***
Total	-397.4	359.3	-38.1	

[a] The p-value of the Wald test that "WW=-AW" for all HFTs jointly is 0.00.

Table 9: HFT cumulative net flow in the lifetime of an institutional order by information content

This table completes the one in Figure 7. The latter one only showed the odd hours.

	Hours since first child order execution																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Low PPI Tercile																	
Mean	-14.5***	-22.8***	-27.7**	-27.1*	-35.8**	-49.3**	-8.1	44.9	42.8	62.2	36.1	35.3	48.9	59.2	98.5	22.5	58.1
t-stat	(2.7)	(2.8)	(2.5)	(1.9)	(2.0)	(2.4)	(0.3)	(1.1)	(0.8)	(1.1)	(0.6)	(0.6)	(0.7)	(0.9)	(1.3)	(0.2)	(0.4)
N	1091	942	856	758	643	525	377	240	176	159	153	147	133	126	109	79	57
Middle PPI Tercile																	
Mean	-13.9***	-11.3	-1.8	17.1	17.9	31.1	42.9	72.4	112.0	86.5	90.9	88.5	59.8	80.2	178.4	192.8	37.2
t-stat	(2.5)	(1.3)	(0.2)	(1.2)	(0.9)	(1.2)	(1.5)	(1.4)	(1.4)	(1.0)	(1.1)	(1.0)	(0.6)	(0.7)	(1.3)	(1.5)	(0.3)
N	968	787	688	597	494	365	271	171	110	96	95	91	85	77	65	41	24
High PPI Tercile																	
Mean	-8.7	-3.8	-18.5*	-11.8	-2.9	1.7	31.7	63.3	96.6	136.9**	151.5***	169.1***	183.2***	178.4**	224.4***	296.5***	236.9*
t-stat	(1.6)	(0.5)	(1.8)	(0.9)	(0.2)	(0.1)	(1.2)	(1.5)	(1.6)	(2.3)	(2.5)	(2.7)	(2.7)	(2.3)	(2.9)	(2.8)	(1.7)
N	1152	994	879	790	702	576	413	269	191	176	162	157	142	131	109	71	46

Figure 9: Histogram start- and end-time of institutional orders

This histogram depicts the distribution of the start- and end-times of institutional orders by binning them into 15-minute intervals.

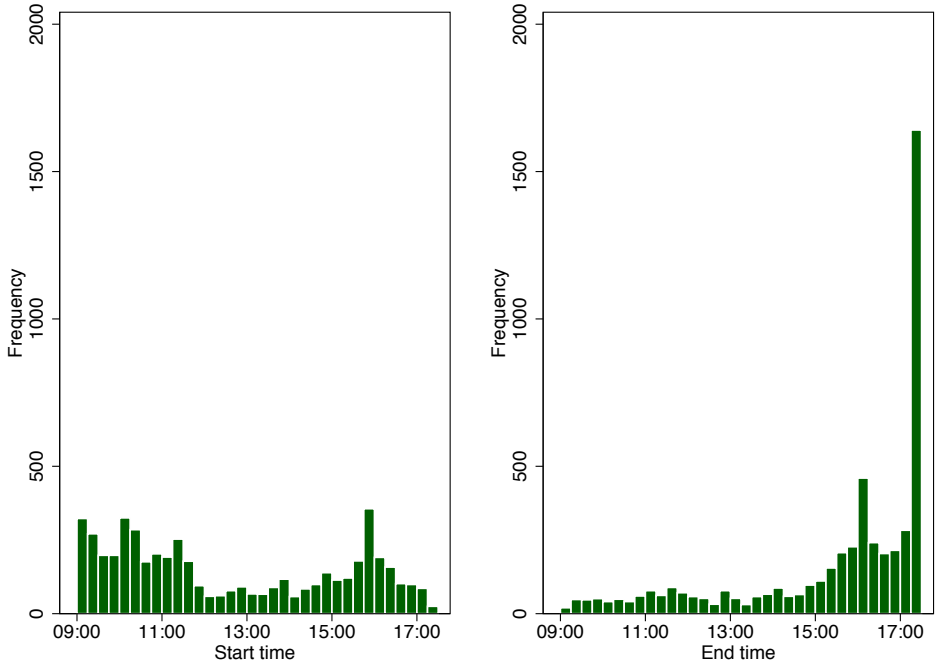


Figure 10: Cumulative net flow of institutional investors in the lifetime of their orders

This figure mirrors Figure 2 in the main text, but this time plots the institution's cumulative net flow instead of HFT cumulative net flow. In other words, it plots cumulative net flow of the institution in the lifetime of its order. The time points are multiples of 30 minutes. At each point the average is taken across all institutional orders that are still executing at that point (i.e., the final child trade has not arrived yet). The size of the sample at each time point is indicated by the dashed green line (right y-axis). Statistical significance is tested based on the t-value of the mean across stock-institution fixed effects (same as the overall mean), with residuals clustered at the stock-period level.

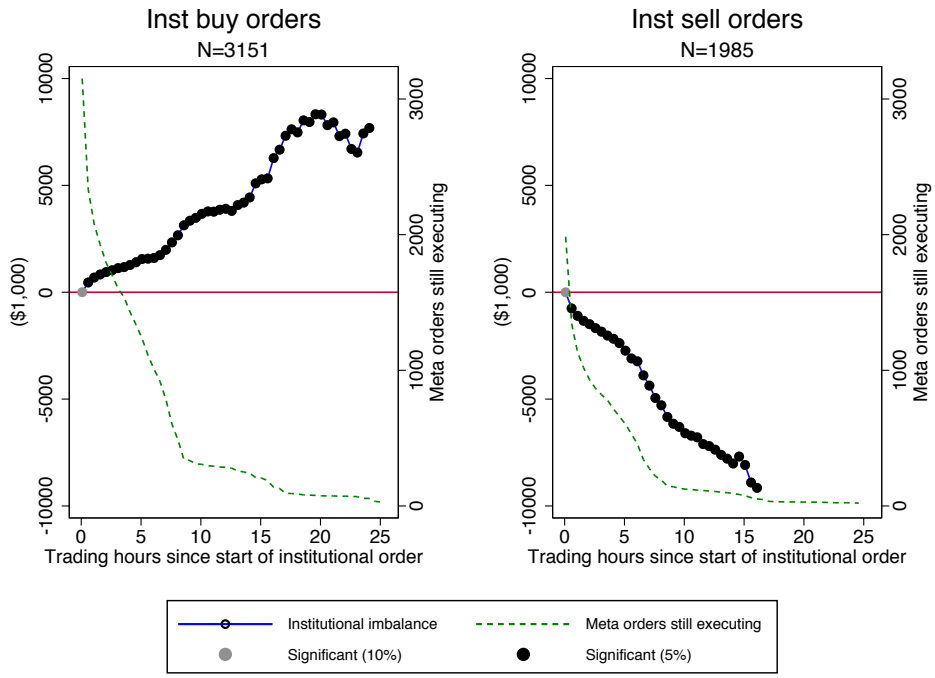
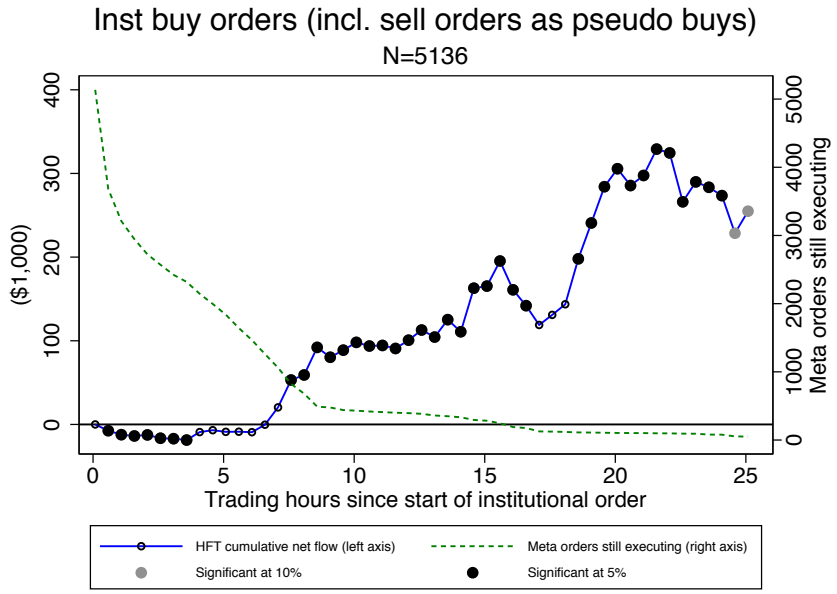


Figure 11: HFT cumulative net flow in the lifetime of an institutional order, buy and sell orders pooled

This figure redoes Figure 2 (top panel) and 3 (bottom panel), but pools buy and sell orders by converting sell orders into pseudo buy orders (by appropriate mirroring).



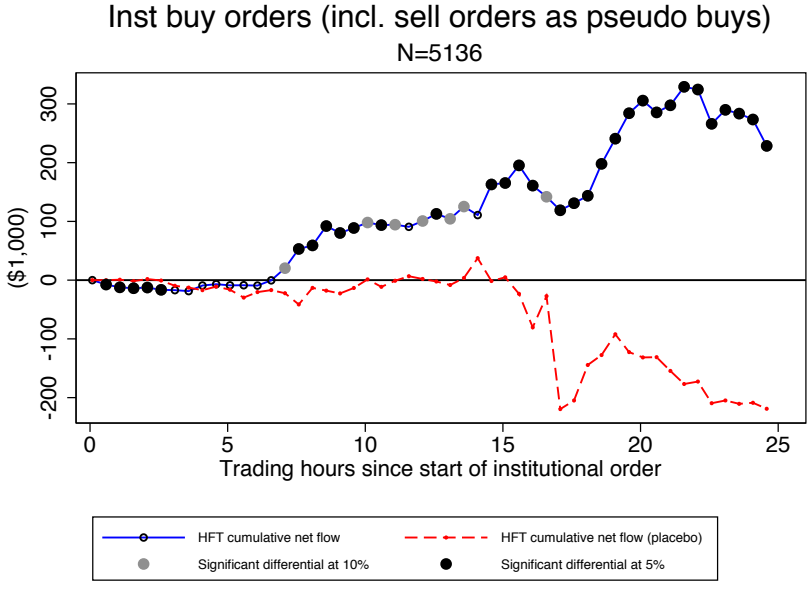


Figure 12: Information revelation in an extended Kyle (1985) model

This figure shows how quickly a strategic informed investor's information is revealed in prices. It does so by simulating from an extended Kyle (1985) model and then running the following "unbiasedness regressions" (as in (1)):

$$v_T = \alpha_t + \beta_t (P_t - P_0) + \varepsilon_t,$$

where v_T is the fundamental value in the model at the end of the trading period (which includes both the public and the investor's private information, i.e., PPI in main paper's analysis in Section 6.2) and $(P_t - P_0)$ is the return from 0 to t. The Kyle model is extended by adding a public information stream. Technically, we add a random walk to prices. Model parameters are picked to match the unbiasedness-regression results in the main paper (Figure 6). The number of trading periods is 100. The variance of noise trading is normalized to one. The variance of private information is 16 and the public-information variance in each period is 9/100. The alpha and beta estimates are based on 10,000 simulations.

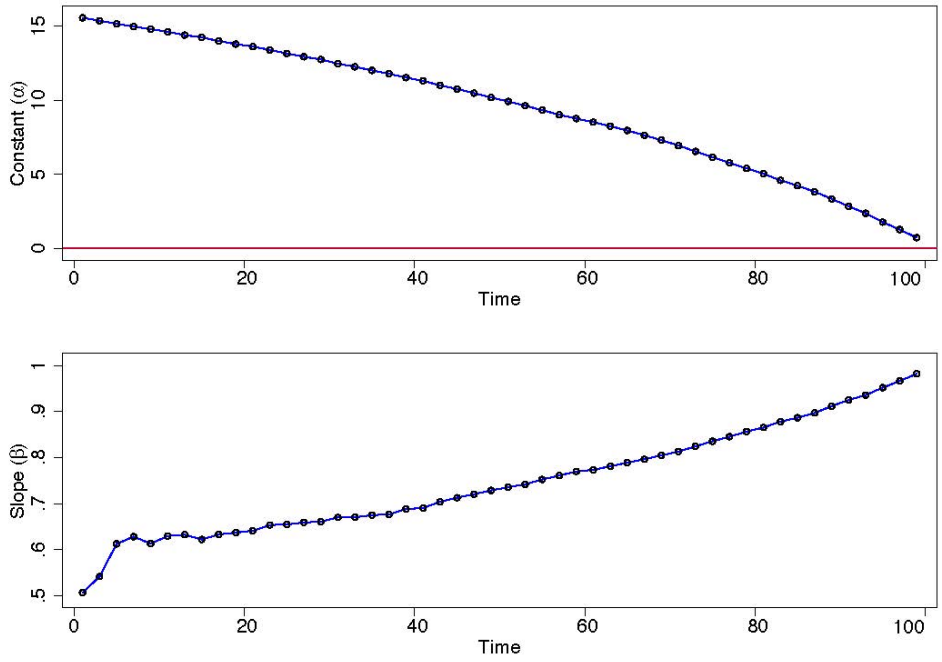
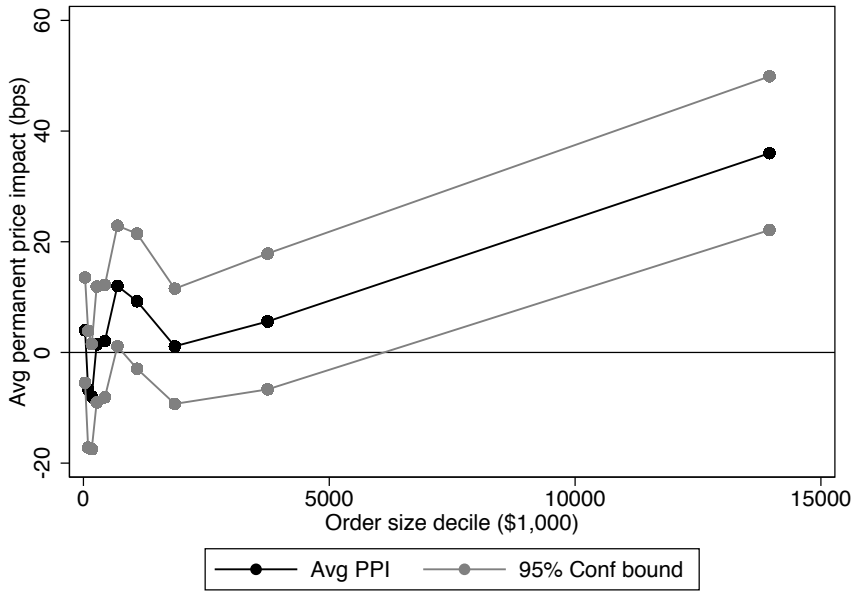


Figure 13: Permanent price impact (PPI) of institutional orders by order size

This figure bins orders by dollar order size or order size expressed relative to average daily volume (ADV). 95% confidence bounds have been added. Units are in brackets.



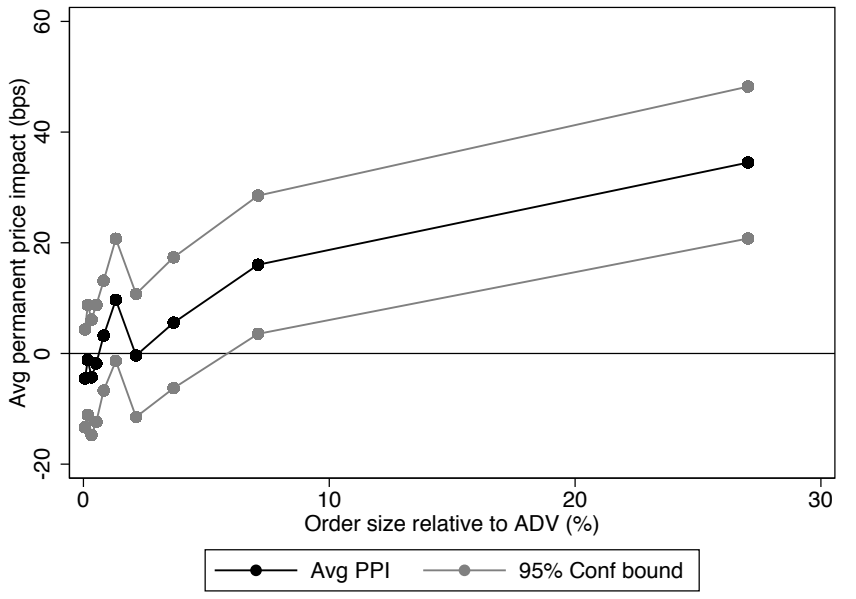


Figure 14: HFT net flow in the lifetime of an institutional order: volume time instead of calendar time

This figure redoes Figure 2 with volume clock time instead of calendar time on the horizontal axis. To create a fair comparison and avoid issues of comparability when concatenating trades across days, we decide to focus only on single-day meta orders combined with the first day only of a multiple-day order. The top panel plots the volume-time pattern, and the bottom panel, for comparison, the calendar-time pattern (similar to Figure 2 but for the subsample only). For the volume-time analysis the time clock is incremented by one hour whenever 1/8.5 of average daily volume is traded on Nasdaq OMX.

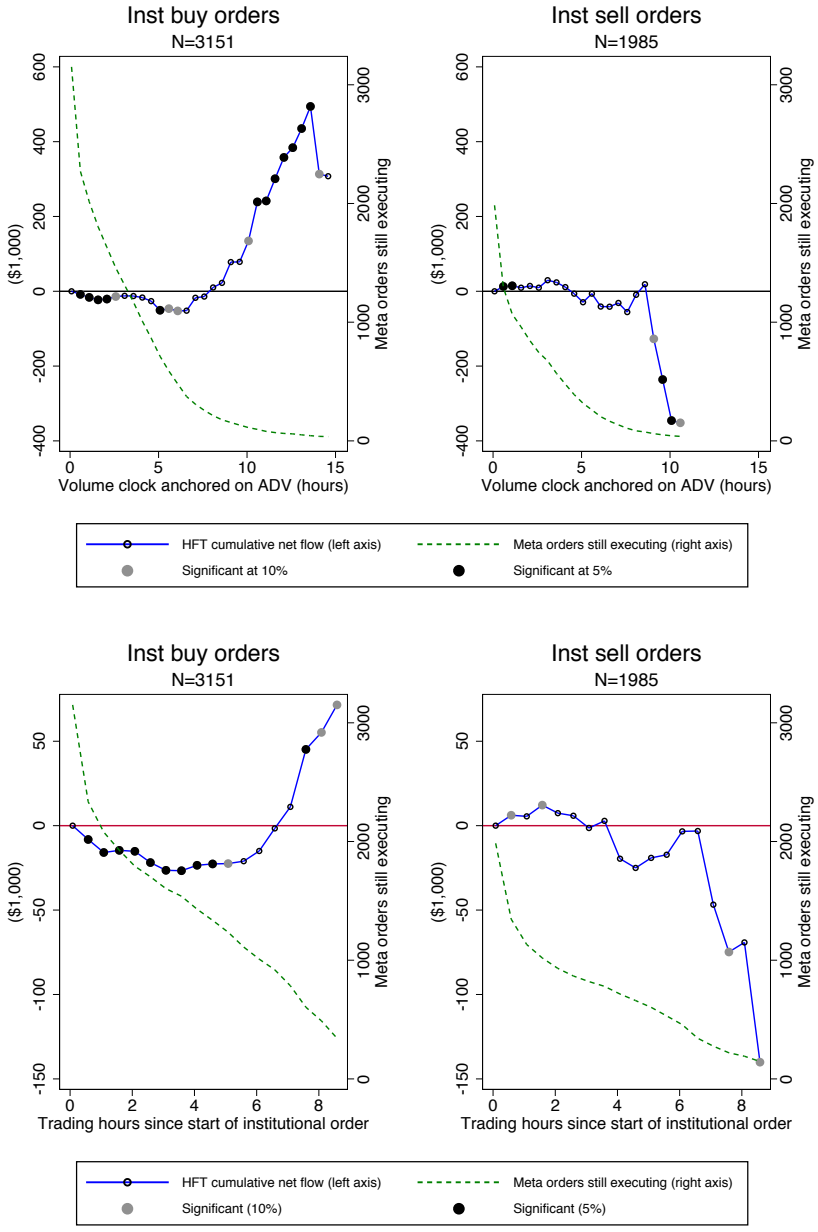


Figure 15: Histogram start- and end-time of with-wind institutional orders

This histograms depict the distribution of the start- and end-times of with-wind institutional orders by binning them in 15-minute intervals. It redoes Figure 9 but now for with-wind orders only, further split into single-day or multiple-day orders.

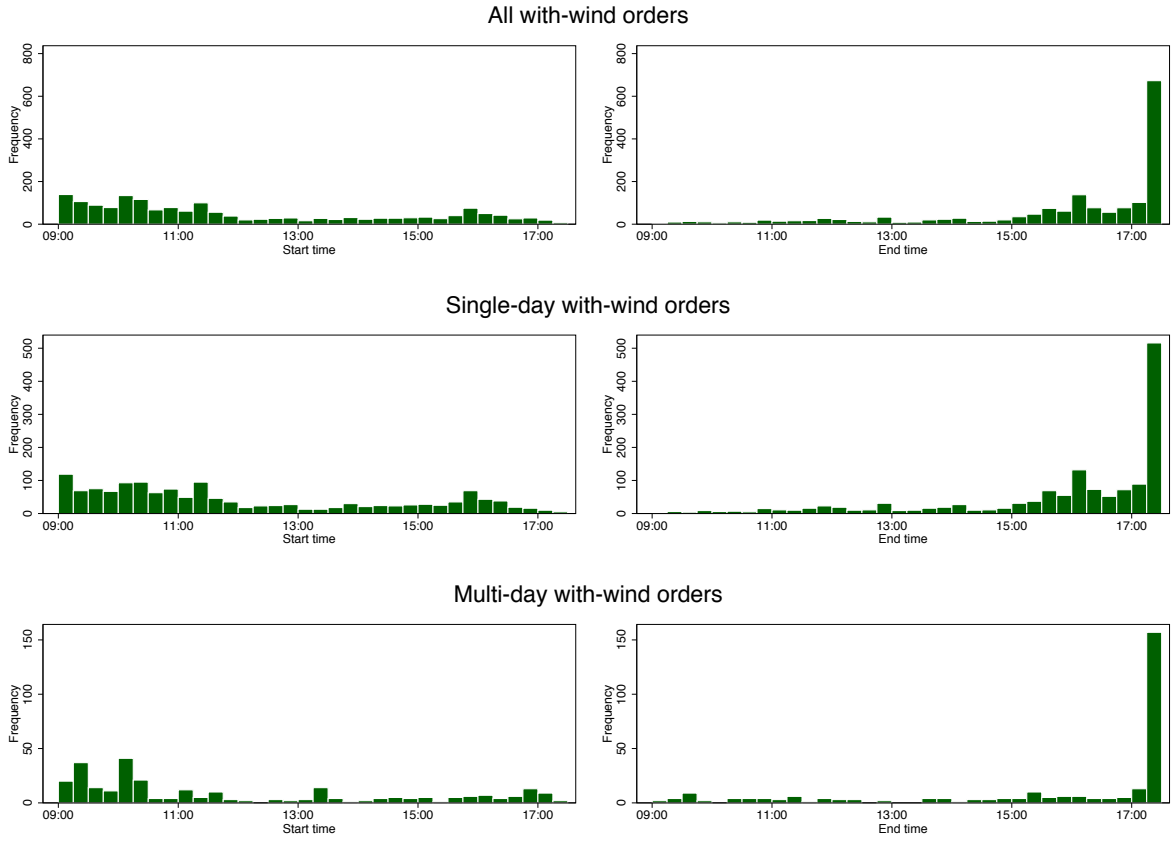


Figure 16: HFT cumulative net flow in the lifetime of an institutional order, for orders that end before or in the final trading hour

This figure redoes Figure 2 for pseudo buys (i.e., buy orders pooled with sell orders by appropriately mirroring the later) split into two subsamples: orders that ended before the final trading hour and orders that ended in the final trading hour.

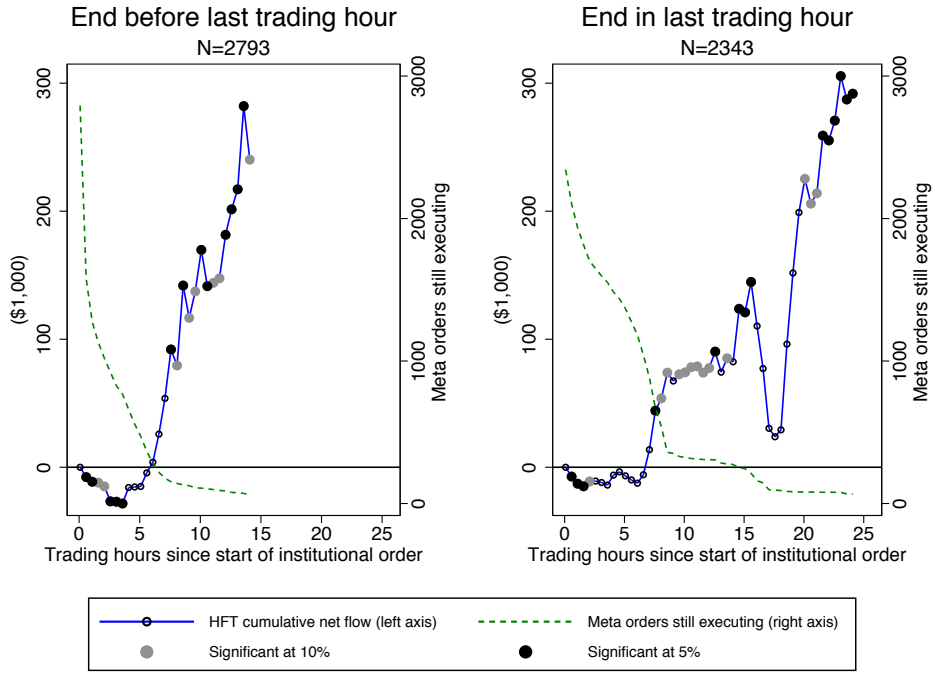


Figure 17: HFT net flow during the lifetime of the institutional order, only for orders on stock-days for which NASDAQ market share exceeds 70%

This figure mirrors Figure 2 in the main text, but is this time based on the subsample of institutional orders where the NASDAQ market share exceeds 70%. The smaller number of observations (863 instead of 5,136) forces us to pool institutional buy and sell orders. We do so by multiplying HFT cumulative net flow by minus one for sell orders. We refer to these orders as pseudo-buy orders.

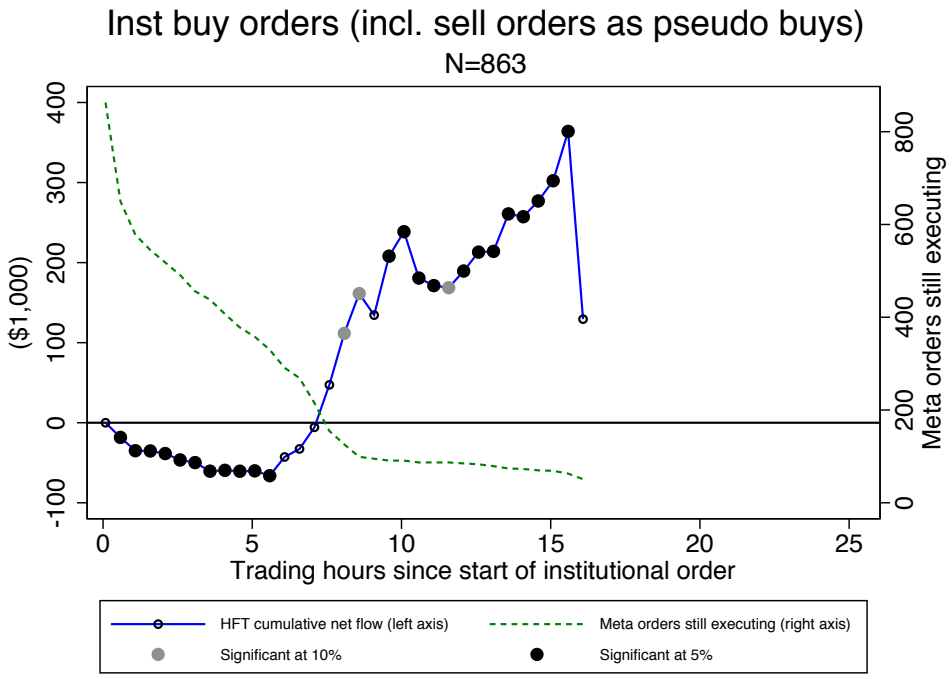


Figure 18: HFT cumulative net flow in the lifetime of institutional orders, by tercile of market concentration

This figure redoes Figure 2 on two subsamples after splitting the sample into terciles based on the market concentration (i.e., the extent to which volume concentrates on one of the lit venues as measured by Herfindahl-Hirschman index). We show results for the high and low tercile. Buys and sells are pooled into pseudo-buy orders for additional power.

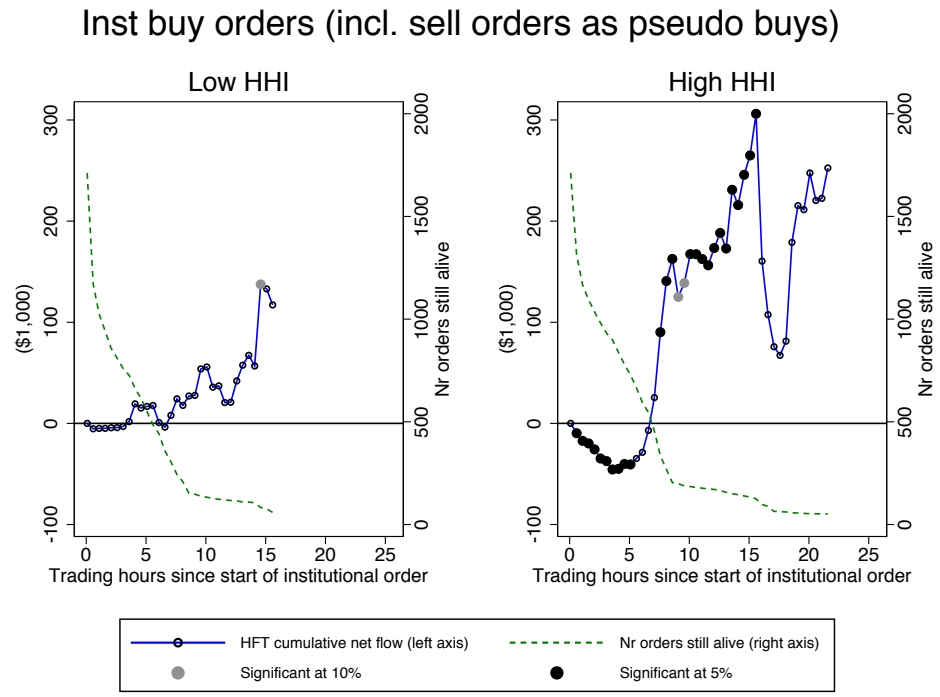


Figure 19: HFT net flow in the lifetime of an institutional order, this time starting one hour before the first child trade executes.

This figure mirrors Figure 2 in the main text, but starts tracking HFT cumulative net flow one hour before the first child trade executes.