Internet Appendix for:
Flashes of trading intent at NASDAQ

This Internet appendix contains additional material to the paper "Flashes of trading intent at NASDAQ".

Table IA.1
Limit Order Book Stocks

The table presents the list of stocks used in the limit order book analysis.

AFAM	CMP	GS	MSA	SWI
AIRM	CNQR	GXP	MSBF	SWM
AJG	COST	HCC	MTOX	TEG
ALJ	CPHC	HCCI	MW	THOR
AMGN	CPII	HEW	MXB	TNDM
AMN	CRAI	HOGS	NAII	TRC
AMRB	CRDN	HQS	NAL	TRMK
AMRI	CRZO	HRLY	NC	TUX
ARJ	CSFL	HSIC	NCR	TWX
ASCA	DGIT	HTLF	NETL	UACL
ATHN	DIOD	HURC	NFX	UEIC
ATMI	DIS	HURN	NGS	UIL
ATO	DPZ	INFA	NWLI	UNT
ATRI	DRC	IPGP	OMG	USMO
ATVI	DRCO	ISH	OSBK	VAR
ATW	DTSI	JOE	OYOG	VIST
AVD	DUCK	JXSB	PATR	VLGEA
AVP	EBIX	KAMN	PBCT	VLY
AWR	EEP	KNDL	PBNY	VOL
BBY	EMCI	KNOT	PCAR	VOLC
BEAV	EME	LARK	PETD	WAG
BEZ	EP	LDSH	PIKE	WDFC
BFSB	ESBK	LEGC	PM	WFMI
BHI	EVR	LFUS	PNM	WIN
BIG	FDS	LG	PRGO	WPO
BKH	FHN	LLL	R	WTR
BKR	FLR	LMNX	RNST	XNPT
BKS	FMR	LNC	SAIA	ZION
BKYF	FNF	LOOP	SF	
BMRC	FRME	LOPE	SFLY	
BTU	FTR	LPNT	SGC	
CASH	FWV	LRN	SKX	
CAVM	GAS	LUFK	SLE	
CCK	GBL	MAN	SMBC	
CCNE	GCO	MAR	SMTC	
CECO	GGG	MCO	SRCL	
CHE	GIW	MCRL	STAN	
CIZN	GLW	MINI	STLY	
CL	GNTX	MLP	STRT	
CMC	GOOG	MMS	STZ	

Table IA.2
Flash Executions Relative to Prevailing NBBO Quote

The table presents the average price improvements of flash order executions over the best prevailing NASDAQ quote and NBBO quotes for 188 stocks. N is the number of buys and sells, *Price impr.* is the price improvement. Price improvements of flash order executions to buy (sell) relative to the best NASDAQ ask (bid) are calculated as: $\mathrm{ask}/P_{buy}^{flash} - 1$ for buys and $P_{sell}^{flash}/\mathrm{bid} - 1$ for sells. The average price improvement of flash order executions to buy (sell) relative to the National Best Offer (NBO) and bid (NBB) quotes are calculated as: $\mathrm{NBO}/P_{buy}^{flash} - 1$ for buys and $P_{sell}^{flash}/\mathrm{NBB} - 1$ for sells. We present the statistics for: (a) all executions, (b) across different stock price levels, (c) across different trade sizes, and (d) across different times of the day.

	Sell flash executions			Buy flash executions		
	N(sells)	Price impr.	p-val	N(buys)	Price impr.	p-val
(a) All flash executions	416712	0.0503%	(0.00)	410209	0.0506%	(0.00)
(b) Price levels (USD)						
≤ 10	16618	0.157%	(0.00)	16465	0.163%	(0.00)
<10, 50	349418	0.051%	(0.00)	343157	0.051%	(0.00)
<50, 100	27643	0.015%	(0.00)	27658	0.015%	(0.00)
<100, 200	16351	0.006%	(0.00)	16226	0.006%	(0.00)
> 200	6682	0.010%	(0.00)	6703	0.008%	(0.00)
(c) Tradesize (shares)						
≤ 100	330750	0.053%	(0.00)	326690	0.053%	(0.00)
<100, 500	78769	0.041%	(0.00)	76790	0.041%	(0.00)
<500, 1000	5533	0.032%	(0.00)	5215	0.031%	(0.00)
<1000, 5000	1603	0.034%	(0.00)	1448	0.032%	(0.00)
> 5000	57	0.038%	(0.00)	66	0.030%	(0.00)
(d) Time of day						
09:00-09:59	58975	0.052%	(0.00)	57130	0.054%	(0.00)
10:00-10:59	94555	0.053%	(0.00)	93446	0.054%	(0.00)
11:00-11:59	55303	0.052%	(0.00)	54433	0.052%	(0.00)
12:00-12:59	42726	0.048%	(0.00)	42427	0.048%	(0.00)
13:00-13:59	44555	0.048%	(0.00)	44327	0.046%	(0.00)
14:00-14:59	53421	0.049%	(0.00)	52029	0.048%	(0.00)
15:00-15:59	67177	0.048%	(0.00)	66417	0.049%	(0.00)

Table IA.3
Flash Order Impact on Market Quality for non-TARP Stocks

The table presents the proportional change in market quality variables after the introduction and removal of flash orders for 1420 non-TARP stocks using end-of-day CRSP data. *Introduction* is the proportional change between the first five days of flash introduction and five days before ((post-pre)/pre), and *Removal* is the proportional change between five days after the removal of flash and five days prior ((post-pre)/pre). Panel A presents the change in the impact on the entire market. *Mean* presents the change in mean and *Median* the change in median. Panel B shows the proportional change in the mean of market quality variables after the introduction and removal of flash orders for stocks sorted according to market capitalization. *,**,*** represent significance at the 10, 5, and 1% level, respectively. All variables are defined in Table A1.

	Spread	Rel. Spread	ILR	Volatility

Panel A. Whole Market

	Introduction			
Mean	-0.14***	-0.17**	-0.22	-0.39***
Median	-0.33***	-0.24***	-0.20***	-0.56***
	Removal			
Mean	0.06	0.07	0.09	0.42***
Median	0.00	0.09***	0.29***	0.69***

Panel B. Sorted by Market Capitalization

	Introduction			
1 (low)	-0.11*	-0.16**	-0.22	-0.25***
2	-0.10	-0.17***	0.13	-0.44***
3 (high)	-0.22***	-0.25***	-0.22***	-0.59***
	Removal			
1 (low)	0.06	0.07	0.09	0.46**
2	0.07	0.08***	-0.01	0.33**
3 (high)	0.05	0.08***	0.35***	0.49***

Table IA.4
Flash Order Impact on Market Quality in Terciles by Flash Activity

The table presents the proportional change in the mean of the market quality variables after the introduction and removal of flash orders for stocks sorted according to the proportion of orders that are flashed, flash ratio. *Introduction* is the proportional change between the first five days of flash introduction and five days before ((post-pre)/pre), and *Removal* is the proportional change between five days after the removal of flash and five days prior ((post-pre)/pre). The sample consists of 1867 stocks using end-of-day CRSP data. All variables are defined in Table A1. *,**,*** represent significance at the 10, 5, and 1% level, respectively.

	Spread	Rel. Spread	ILR	Volatility

Panel A. Whole Sample

	Spread	Rel. Spread	ILR	Volatility
		Introduction		
1 (low)	-0.08***	-0.16***	-0.12**	-0.37***
2	-0.14***	-0.13***	-0.21***	-0.30***
3 (high)	-0.10***	-0.07***	-0.68	-0.44***
		Removal		
1 (low)	0.04***	0.10***	0.04	0.35*
2	0.06	0.07	0.35**	0.26
3 (high)	-0.06	0.02***	-0.25	0.35*

Panel B. Non TARP

	Spread	Rel. Spread	ILR	Volatility
		Introduction		
1 (low)	-0.03***	-0.15***	-0.02***	-0.36***
2	-0.16***	-0.15***	-0.34***	-0.32***
3 (high)	-0.24***	-0.23***	-0.17***	-0.55***
		Removal		
1 (low)	0.06***	0.11***	0.08	0.43*
2	0.09	0.07*	0.15*	0.33
3 (high)	-0.01	0.04***	0.06	0.56**

Table IA.5
Flash Order Impact on Market Quality Double Sorted by Market Cap and Flash Activity

The table presents the proportional change in the mean of market quality variables after the introduction and removal of flash orders for stocks double sorted according to market capitalization and the flash ratio. *Introduction* is the proportional change between the first five days of flash introduction and five days before ((post-pre)/pre), and *Removal* is the proportional change between five days after the removal of flash and five days prior ((post-pre)/pre). The sample consists of 1867 stocks using end-of-day CRSP data. All variables are defined in Table A1. *,**,*** represent significance at the 10, 5, and 1% level, respectively.

	Spread	Rel. Spread	ILR	Volatility
Panel A. Introduction				
Market Cap Tercile 1 (Low)				
1 (low)	-0.08***	-0.15***	0.10	-0.31***
2	-0.07**	-0.10***	-0.12***	-0.03***
3 (high)	-0.03	-0.04	0.03	-0.23
Market Cap Tercile 2				
1 (low)	-0.15***	-0.18***	0.13	-0.48***
2	-0.25***	-0.24***	0.07	-0.32***
3 (high)	-0.09***	-0.11***	-0.84***	-0.35***
Market Cap Tercile 3 (High)				
1 (low)	0.06	-0.05	-0.22	-0.54***
2	-0.25***	-0.26***	-0.64***	-0.64***
3 (high)	-0.30***	-0.25***	-0.23***	-0.56***
Panel B. Removal				
Market Cap Tercile 1 (Low)				
1 (low)	0.10***	0.16***	0.65	0.31*
2	0.09**	0.06*	0.38	0.19
3 (high)	-0.07	0.02*	-0.26	-0.23
Market Cap Tercile 2				
1 (low)	0.07***	0.08***	-0.22	0.51
2	-0.11	0.10	-0.38	0.24
3 (high)	0.06	0.10**	0.46**	0.95
Market Cap Tercile 3 (High)				
1 (low)	-0.11	-0.07	0.21	0.78
2	0.12**	0.15***	0.36***	0.55***
3 (high)	0.10***	0.09***	0.41**	0.60**

Table IA.6
Difference in Difference - Robustness

The table shows robustness checks for the difference-in-difference analysis. Panel A shows mean difference in difference between the CRSP and the Toronto Stock Exchange (TSE) market quality variables (treatment-control) of a 20-day pre/post window event study for the entire sample, and the results sorted according to market capitalization. *Introduction* is the difference between the flash introduction and before (post-pre), and *Removal* is the difference between the removal of flash and prior (post-pre). Panel B shows the fixed effect regressions for non-TARP stocks of the market quality difference between the CRSP and TSE (treatment-control) on a flash period dummy for the sample period, April 1-October 31, 2009. *Market Cap. Diff.* is the difference in log market capitalization between CRSP and TSE stocks, *Inv. Price Diff.* is the difference in inverse prices between CRSP and TSE stocks, *Volume Diff.* is the difference in volume between CRSP and TSE stocks. *Flash Dummy* is a binary variable that is one for the period June 5 - August 31, 2009, and zero otherwise. All other variables are defined in Table A1. All regressions include a constant, not reported to conserve space. p-values are calculated using ? two-way clustered robust standard errors. *,**,*** represent significance at the 10, 5, and 1% level, respectively.

	Spread	Rel. Spread	ILR	Volatility
Panel A. Event Study				
Whole Market				
Introduction	-0.024***	-0.053***	-0.023	0.000
Removal	0.003	0.008	0.029	0.002***
Sorted by Market Cap.				
Introduction				
1 (low)	-0.008	0.017	-0.057	0.000
2	-0.030***	-0.089***	-0.001	0.000
3 (high)	-0.036***	-0.091***	-0.009	-0.001**
Removal				
1 (low)	0.002	-0.006	0.071	0.002***
2	0.008***	0.041***	-0.001	0.002***
3 (high)	-0.001	-0.011	0.015	0.001***
Panel B. Non TARP				
Flash Dummy	-0.030***	-0.139***	-0.680***	-0.005***
Market Cap. Diff.	-0.050***	-0.230**	-0.008	0.313***
Inv. Price Diff.	-1.160***	-1.124***	-7.623***	0.053***
Volume Diff.	-0.004***	-0.015***	-0.010*	-0.003***
Adj. R^2	0.59	0.19	0.16	0.28

Table IA.7
U.K. and Canada Match Group

The table shows results for the difference-in-difference regression where the match group is the combined stocks of Toronto Stock Exchange (481 stocks) and London Stock Exchange (741 stocks). The results are for fixed effect regressions of the market quality difference between the CRSP and matched group (treatment-control) on a flash period dummy for the sample period: April 1-October 31, 2009. *Market Cap. Diff.* is the difference in log market capitalization, *Inv. Price Diff.* is the difference in inverse prices, and *Volume Diff.* is the difference in volume between CRSP and matched stocks. Flash Dummy is a binary variable that is one for the period June 5-August 31, 2009, and zero otherwise. All variables are defined in Table A1. All regressions include a constant, not reported to conserve space. p-values are calculated using ? two-way clustered robust standard errors. *,**,*** represent significance at the 10, 5, and 1% level, respectively.

	Spread	Rel. Spread	ILR	Volatility
Flash Dummy	-0.006***	-0.013***	-0.025***	-0.002***
Market Cap. Diff.	0.006**	-0.076**	-0.466***	-0.007***
Inv. Price Diff.	-0.674***	-0.107	-4.902***	0.042***
Volume Diff.	0.000	-0.030	0.112**	0.041***
Adj. R^2	0.52	0.44	0.20	0.27

Table IA.8
Arguments on Flash Orders

Against	For
Market Quality	
Discourage the public display of trading interest and harm quote competition among markets, reduce incentives for public display of quotations.	Increase in volume and reduction of spreads, increase in liquidity
Deprive those who publicly display their interest at the best price from receiving a speedy execution at that price. Harm price discovery.	Attract liquidity from market participants who are not willing to display their trading interest publicly. Flash orders may provide an opportunity for better execution than if orders were routed elsewhere.
Front-running (flashed orders that do not receive an execution in the flash process are less likely to receive a quality execution elsewhere.) Quotes being taken away.	Increase the chance of execution at the best price and lower cost.
Harm the interest of long-term investors to the benefit of high-frequency traders.	Decrease volatility and provide more liquidity in volatile markets.
Diverts a certain amount of order flow that otherwise might be routed directly to execute against displayed quotations in other markets.	Orders to be routed could go to dark pool, thus flash reduce dark pool volume.
Fairness	
Detract from the fairness and efficiency of the national market system as the best quotations from specific markets are made available to a limited number of market participants.	
"Last mover" advantage, cannot have price and time priority because flash order comes at same price but later time and is still executed immediately, i.e. before outstanding orders.	
Maximize an exchange's competitive advantage, since exchanges compete on volume of executed trades.	Reduce flight to overseas markets
Those who are highly concerned about information leakage generally would be unlikely to flash their order information to a large number of professional traders.	

Figure IA.1
Propensity Score Distribution

The figure shows the propensity score distribution of the treated (U.S.) and control (TSE) groups. The treated group is in panel 1, and the control group is in panel 0. The logit regression to estimate the propensity scores is run over the period April 1-June 4, 2009.