Internet Appendix for
"Slow-Moving Capital and Execution Costs: Evidence from a Major Trading Glitch"

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This appendix includes detailed chronological glitch-related news, a robustness test regarding the definition of glitch affected stocks, and additional figures and tables mentioned in the main text.

1. Chronological List of Glitch-Related News

We have manually examined all of the public news articles regarding the glitch using Bloomberg. In the following section, we briefly discuss major news articles or notes appearing in the Bloomberg terminal. At 09:48 AM, the first public news article regarding the glitch is published by Bloomberg First Word (BFW) stating that KC stock has dropped 5.1% in heavy volume.[1] This price movement implies that some investors have already had information about the potential losses of KC due to its involvement in the erroneous trades. At 10:01 AM, BFW shared the statement of a KC spokeswoman stating that KC is looking into stock swings.[2] At 10:05 AM, BFW cited a NYSE floor trader who briefed that trades coming through KC caused volatility in some stocks early in the session.[3] At 10:16 AM, Bloomberg News (BN) published an article stating that swings that exceeded 10 percent in dozens of U.S. stocks without accompanying news spurred speculation that a computer program was affecting prices.[4] This article shared a couple of stock names with double digit percentage changes and stated that "swings narrowed minutes later." At 10:21 AM, KC stock was down 12%. At 10:40 AM, BFW cited another NYSE floor trader stating that the trading reverted to normal. This trader has said that there *"was a program that went crazy and they realized they made a mistake and everything reversed out of it. There was an algo that apparently hit the floor and indiscriminately took stocks up and then back down."*[5] At 10:41 AM, NYSE released a trader update stating that the NYSE and NYSE MKT are reviewing the trades in 148 symbols occurring between 09:30 AM and 10:15 AM and they published the list of these symbols in a spreadsheet at 11:48 AM.[6] The review has then been revised to 140 symbols and

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[1] Source: "Knight Capital Drops 5.1% in Active Trading", *Bloomberg*, August 1, 2012.
[2] Source: "Knight comments after 10%-plus Moves in some U.S. Stocks", *Bloomberg*, August 1, 2012.
[3] Source: "Problems in Stock Trading Coming Via Knight, Weisberg Says", *Bloomberg*, August 1, 2012.
[4] Source: "Swings in Small-Cap Stocks Spur Speculation on Computer Trading", *Bloomberg*, August 1, 2012.
[5] Source: "Trading 'Seems to Be Back to Normal,' Doreen Mogavero Says", *Bloomberg*, August 1, 2012.
[6] Source: "CEE Review Initiated for 148 Symbols", *NYSE*, August 1, 2012.

this list was also published by *Wall Street Journal* at 12:41 PM.[7] At 12:02 PM, BFW cited a tweet stating that the SEC is examining the Knight trading errors.[8] At 12:55 PM, this news is confirmed by the SEC in an emailed statement.[9] At 14:57 PM, NYSE stated that they have determined to cancel trades in six symbols which executed 30% or more above or below the NYSE/NYSE MKT opening price today between 09:30 AM and 10:15:00 AM. NYSE also stated that the situation is still under review by all relevant regulatory authorities.[10]

2.   NYSE's List of Potentially Affected Stocks

As reported in the previous section, at 11:48am on August 1, 2012, NYSE released a trader update stating that NYSE and NYSE MKT are reviewing trades in 140 symbols and provided a link to a spreadsheet including all of the tickers (see https://www.nyse.com/publicdocs/nyse/notifications/trader-update/nyse_cee_symbols_aug_1_2012.xls). 49 of these stocks are included in the S&P 500 index and thus they may be traded in our institutional data set. Since this is an initial list that NYSE reported right after the news of the glitch, it may not be completely accurate. In this section, we discuss how our list of glitch-affected stocks reported in Table 3 of the paper is different from these 49 stocks. For robustness, we also rerun our main regression using this list as the universe of glitch-affected stocks.

36 out of 37 stocks in our main list of glitch-affected stocks (identified based on the abnormal volume criterion as discussed in section 4.3 in the main text) are also included in the NYSE's list. The one stock the NYSE list does not include is LH, which has a RATIO of 14.2 (on August 1) with a corresponding z-score of 16.1. Table IA.3 below reports the statistics for the remaining 13 stocks that are not included in our main list. 4 stocks actually have negative z-scores, which implies that they did not have any increase in their number of trades on August 1. 5 stocks have z-scores that are positive but less than 2. 2 stocks have z-scores that are between 2 and 3. Finally, 2 stocks have z-scores that are greater than 5. These two stocks are actually included in our extended list of glitch-affected stocks used for the robustness test reported in Section 7.4. Note that there are 10 additional stocks that are included in our extended list reported in section 7.4 (i.e., all stocks with z-scores greater than 5) but are not reported in the list provided by NYSE.

We rerun our main regression using the NYSE list to identify glitch-affected stocks. Given the significant overlap across the lists, we expect our findings to be robust to this list

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[7]Source: "Trading Snafu: The List of the 148 Affected Stocks", *Wall Street Journal*, August 1, 2012.

[8]Source: "SEC Seen Examining Knight Trading Errors, Gasparino Tweets", *Bloomberg*, August 1, 2012.

[9]Source: "SEC 'Closely Monitoring' Trading After Early Swings in Stocks", *Bloomberg*, August 1, 2012.

[10]Source: "NYSE to Cancel Trades in Six Stocks After Trading Problems", *Wall Street Journal*, August 1, 2012.

of affected stocks. Table IA.4 verifies this as the results are indeed very similar to those of the main analysis in Section 5.1.

Figure IA.1: Cumulative return of bought and sold stocks following the glitch. This figure plots the average cumulative idiosyncratic return and total share volume of glitch-affected stocks that are bought (9:30-10:00 AM return> 1%) and sold (9:30-10:00 AM return< −1%) over the five trading days following the glitch. For each stock, idiosyncratic returns are the residuals of a regression of the stock's one-minute log return on the value-weighted log market return of all stocks in the sample excluding glitch-affected stocks (without an intercept). The figure reports the cumulative idiosyncratic returns for bought and sold stocks.

cumulative idiosyncratic return of bought and sold stocks

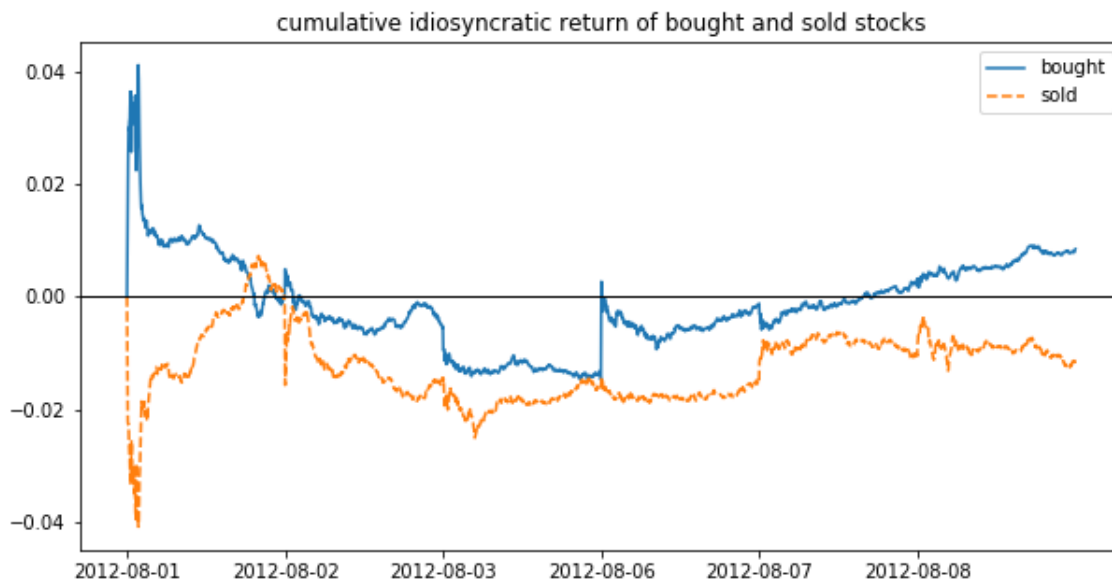Figure IA.1 reports the price patterns of bought and sold stocks over the next five trading days. The small number of stocks in each group (14 and 17) requires caution when interpreting the patterns over several days as idiosyncratic events are likely to occur. In this respect, the high return of bought stocks from the market close on August 3 to the open on August 6 is mostly driven by an idiosyncratic event.

Figure IA.2: Intraday effective spread, realized spread, and price impact with different windows to compute realized spread and price impact. For each stock affected by the glitch, liquidity measures for all transactions are averaged using dollar-weighting over non-overlapping 1-minute intervals starting at 9:30 AM on August 1, 2012. The plotted liquidity measure in a given interval is computed as the cross-sectional median in the interval. Each plot uses a different time window to compute realized spread and price impact.
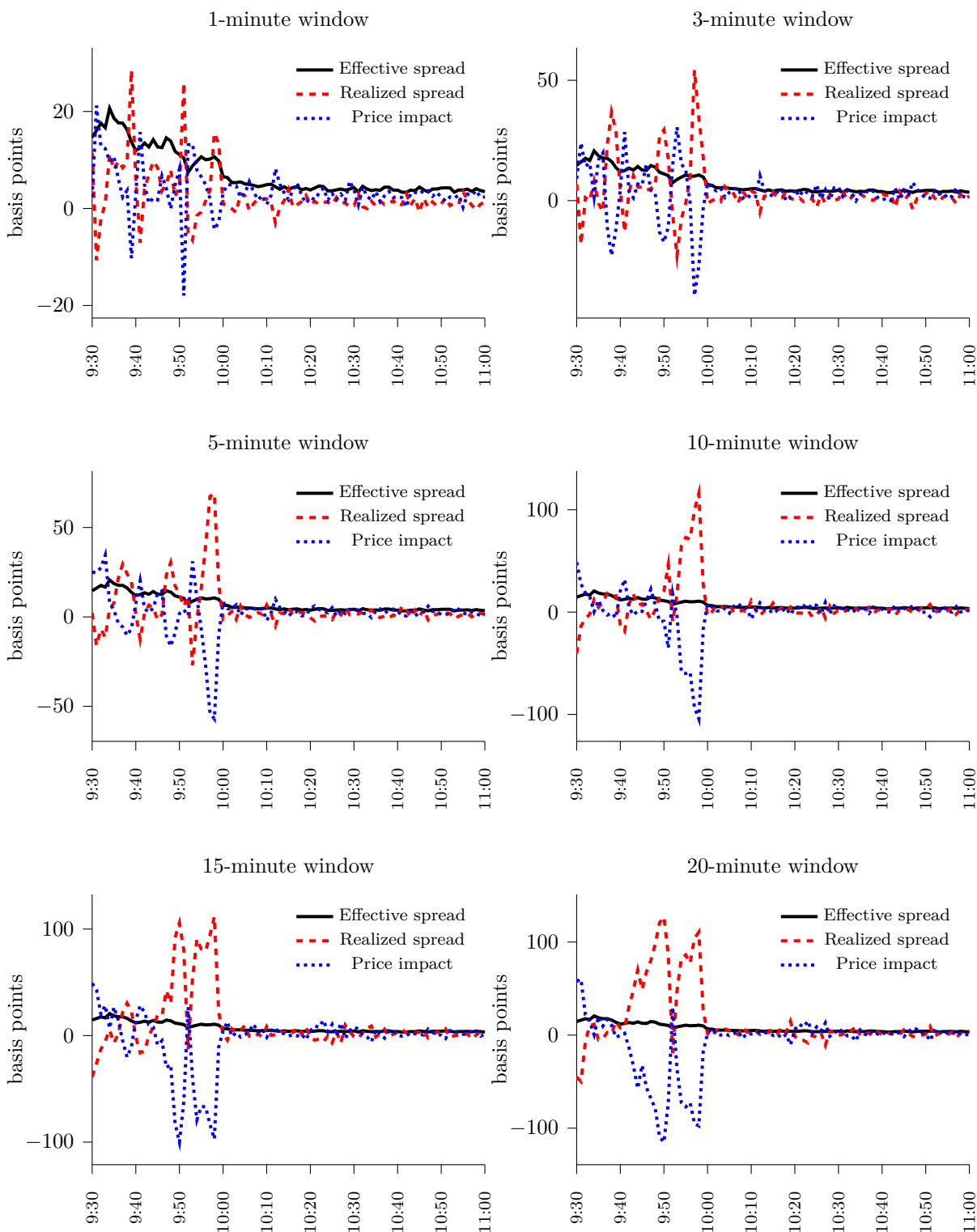
Table IA.1: Historical statistics on the stocks which have higher number of trades than SPY on August 1, 2012. The data is from August 1, 2011 to July 31, 2012. N is the number of trading days for which the stock had a higher number of trades than SPY in the first 30 minutes of trading. The corresponding probability is computed by dividing N by 253. We also report the average and the corresponding standard deviation for the ratio of the number of trades in the stock to that of SPY in the first 30 minutes.

Ticker	N	Probability	Avg Ratio	Std. Dev.
BAC	17	0.067	0.524	0.271
C	6	0.024	0.429	0.219
BBY	1	0.004	0.073	0.093
F	1	0.004	0.229	0.132
AA	0	0	0.132	0.066
AFL	0	0	0.034	0.020
AGN	0	0	0.019	0.014
AMD	0	0	0.096	0.081
AMT	0	0	0.030	0.015
ANF	0	0	0.045	0.051
ANR	0	0	0.116	0.065
BRKB	0	0	0.047	0.015
COH	0	0	0.047	0.057
CVS	0	0	0.075	0.052
DD	0	0	0.060	0.031
DE	0	0	0.052	0.030
DOW	0	0	0.078	0.036
EXC	0	0	0.050	0.031
FRX	0	0	0.019	0.011
GLW	0	0	0.101	0.066
GME	0	0	0.032	0.033
GNW	0	0	0.058	0.057
GT	0	0	0.053	0.043
HOG	0	0	0.026	0.021
HUM	0	0	0.026	0.027
JNPR	0	0	0.085	0.072
JWN	0	0	0.028	0.020
LH	0	0	0.010	0.008
LOW	0	0	0.133	0.081
LSI	0	0	0.057	0.050
MPC	0	0	0.041	0.037
PEP	0	0	0.066	0.039
PFE	0	0	0.208	0.081
SWN	0	0	0.055	0.046
VZ	0	0	0.105	0.050
WFC	0	0	0.250	0.091
WLP	0	0	0.040	0.040

Table IA.2: Distributional statistics of the ratio of the number of trades in the first half hour to the average number of trades realized in the same interval over the prior five trading days. The statistics are based on NYSE-listed S&P 500 stocks using daily data from August 1, 2011 to July 31, 2012. We compute the size quintile breakpoints using the market capitalization values observed on August 1, 2011. Large (Small) firms in the highest (lowest) quintile have market capitalization higher (lower) than $27.3 (5.8) billion.

Statistic	N	Mean	Std Dev	Min	P25	Median	P75	P95	P99	Max
All	99,367	1.08	0.88	0.004	0.67	0.91	1.24	2.14	4.02	48.17
Large	20,172	1.05	0.62	0.16	0.72	0.92	1.20	1.96	3.33	16.07
Small	23,314	1.09	1.02	0.03	0.64	0.89	1.26	2.26	4.59	36.67

Table IA.3: The trade statistics of the stocks that are included in the NYSE list but excluded from our main list reported in Table 3 of the main text. The panel shows the number of trades for these stocks between 9:30 and 10:00 AM on August 1, 2012 (AUG1), as well as the average number of trades in the same interval over the previous five trading days (AVG). RATIO is the ratio of AUG1 over AVG. Z denotes the z-score of RATIO, which is measured in terms of standard deviations from the mean which are computed at the stock-level from daily data between August 1, 2011 and July 31, 2012.. The final column shows whether the stock is included in our extended list of glitch-affected stocks reported in Section 7.4.

Ticker	AUG1	AVG	RATIO	Z	ExtendedList?
AIG	4163	4736.4	0.88	-0.25	No
AXP	4291	3262.4	1.32	0.46	No
CAT	8190	8555.2	0.96	-0.16	No
CHK	6823	5480.8	1.24	0.15	No
GE	10727	12571.0	0.85	-0.41	No
GIS	4640	1509.6	3.07	2.96	No
LEN	3018	3300.8	0.91	-0.25	No
LUV	10278	2770.2	3.71	5.43	Yes
NEM	20080	5357.4	3.75	6.42	Yes
T	17893	11738.2	1.52	1.14	No
TIE	874	403.2	2.17	2.25	No
WAG	15099	3754.6	4.02	1.94	No
WPI	3267	1138.6	2.87	0.79	No

Table IA.4: Panel regressions of institutional liquidity measures and matched standard liquidity measures using the list of potentially glitch-affected stocks provided by NYSE. This table reports the results of regressing cost measures on indicator variables, control variables, and day and stock fixed effects using institutional parent-order executions on NYSE-listed S&P 500 stocks from January 2012 to December 2012. *GlitchDay0* equals one if the parent-order execution is made on a glitch-affected stock on the day of the glitch. *GlitchNextWeek*, *GlitchAug9ToAug31*, and *GlitchPost* are defined in a similar way for parent-order executions made within the next 5 business days after the glitch, between August 9th and August 31st (included), and on any date after August 31st, respectively. *DMM0* equals one if the parent-order execution is made on a stock for which Knight Capital is the designated market maker on the day of the glitch. *DMMNextWeek*, *DMMAug9ToAug31*, and *DMMPost* are defined in a similar way for parent-order executions made within the next 5 business days after the glitch, between August 9th and August 31st (included), and on any date after August 31st, respectively. The liquidity measures are defined in Section 3. Standard errors are given in parentheses and are double-clustered by day and stock. *, **, and *** denote significance at the 10%, 5%, and 1% level.

Dependent variable:	VWAP Slippage	Implementation Shortfall	Effective Spread	Realized Spread	Price Impact
GlitchDay0	3.61**	12.33*	0.68***	−0.02	0.69
	(1.41)	(6.74)	(0.21)	(0.42)	(0.54)
GlitchNextWeek	5.69***	16.71***	0.26	−0.86	1.12*
	(1.11)	(5.59)	(0.27)	(0.66)	(0.68)
GlitchAug9ToAug31	0.37	0.64	0.33	0.10	0.24
	(0.58)	(2.86)	(0.21)	(0.24)	(0.30)
GlitchPost	0.02	−1.02	0.09	−0.02	0.11
	(0.52)	(2.47)	(0.21)	(0.23)	(0.28)
DMM0	5.32***	33.80***	−0.05	−1.01***	0.96***
	(1.00)	(8.56)	(0.13)	(0.34)	(0.36)
DMMNextWeek	−2.97	5.98	−0.01	−0.63	0.62
	(2.93)	(5.74)	(0.23)	(0.67)	(0.59)
DMMAug9ToAug31	0.01	−3.40	−0.03	0.07	−0.11
	(1.07)	(2.82)	(0.19)	(0.31)	(0.42)
PostDMM	−0.003	−3.57	−0.04	0.08	−0.12
	(0.80)	(5.35)	(0.17)	(0.26)	(0.32)
Participation Rate	14.76***	35.57***	0.88**	−0.84	1.72*
	(2.17)	(6.68)	(0.42)	(1.02)	(1.02)
Fraction of Daily Volume	25.90***	129.08***	−6.90***	1.80	−8.70***
	(6.09)	(49.05)	(1.20)	(2.39)	(2.23)
Relative Daily Volume	−0.26	−0.29	−0.26***	−0.24***	−0.02
	(0.50)	(1.73)	(0.07)	(0.08)	(0.10)
IsEarningsDay	0.03	8.69**	−0.11	−0.19	0.07
	(0.89)	(4.19)	(0.13)	(0.30)	(0.34)
Interval Turnover	0.26***	0.30	−0.01	0.02	−0.03*
	(0.08)	(0.40)	(0.01)	(0.01)	(0.02)
Interval Volatility	7.45	60.75	200.91***	31.60	169.31***
	(30.64)	(130.87)	(45.04)	(27.72)	(55.45)
Day Volatility	−70.88	−802.93**	−17.16	24.19	−41.35
	(62.40)	(315.59)	(11.87)	(20.79)	(25.86)
Execution Duration Fraction	3.00***	5.43	0.43***	0.19	0.24
	(0.76)	(3.60)	(0.12)	(0.17)	(0.17)
Day Return	21.00*	−161.39**	−2.11*	−6.27**	4.16
	(11.14)	(72.27)	(1.09)	(2.79)	(2.89)
abs(Day Return)	−7.77	274.81**	−2.49	−15.95***	13.46***
	(19.87)	(118.63)	(2.51)	(3.99)	(4.77)
IsVWAP	−3.27***	−7.47***	0.005	−0.27	0.27
	(0.37)	(1.21)	(0.07)	(0.16)	(0.18)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Obs.s	31,792	31,792	31,641	31,641	31,641
Adjusted R^2	0.10	0.04	0.61	0.02	0.15