

Attention: How High-Frequency Trading Improves Price Efficiency Following Earnings Announcements

Internet Appendix

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This Internet Appendix provides discussions of:

1. the **procedure to identify earnings announcement dates and times**, and
2. the **instrumental variable (IV) analysis for a binary endogenous variable**;

as well as the following additional results discussed in the main article:

- **IA-1: Principal Component Analysis results.** We construct *Aggregate PCA*, an alternative composite measure of low attention, as the first principal component of five attention proxies: *Busy Day*, *Slow Analyst Speed*, *Low EDGAR*, *High News Distraction*, and *Friday*. Key statistics of the principal component analysis are provided in this table.
- **IA-2: Characteristics of stocks with earnings announcements meeting attention-related criteria**
 - Panel A shows the characteristics of stocks with low attention and high unexpected earnings.
 - Panel B shows the characteristics of stocks with low attention, high unexpected earnings, and HFT trading.
 - Panel C reports the significance of the differences between Panels A and B.
- **IA-3: HFT internal margin and price efficiency**
 - Panel A shows short-term price efficiency for small, medium, and large firms.
 - Panel B shows long-term price efficiency (PEAD) for small, medium, and large firms.
- **IA-4: Internal margin and price efficiency, using abnormal HFT measure**
 - Panel A shows results excluding *HighUE*Control* interactions
 - Panel B shows results including *HighUE*Control* interactions
- **IA-5: HFTs and short-term price efficiency with 1-day and 3-day horizons**

- Panel A reports results for one-day *CAR*.
- Panel B reports results for three-day *CAR*.
- **IA-6: HFTs and long-term price efficiency with 30-day horizon**
- **IA-7: HFTs and price efficiency under alternative high-frequency trading cutoffs**
 - Panel A reports results using HFT defined as equaling one when HFT represents more than 5% of trading volume following the earnings announcement, else zero.
 - Panel B reports results using HFT defined as equaling one when HFTs trade within two hours of the earnings announcement, else zero.
- **IA-8: HFTs and price efficiency using alternative unexpected earnings measure.**
Results are reported for regressions in which Standardized Unexpected Earnings (SUE) are used instead of Unexpected Earnings (used in the main analysis).
- **IA-9: HFTs and price efficiency using Aggregate Percentile proxy.** Results are reported for regressions using the Aggregate Percentile measure of low attention, which is equal to one for an earnings announcement if the average of the quarterly-ranked percentiles of *Busy Day*, *Analyst Speed*, *News Distraction*, and *EDGAR* is higher than the quarterly median, else zero.
- **IA-10: HFTs and price efficiency without interacted controls and for low-attention subset**
 - Panel A shows regression results excluding *HighUE*Control* interaction terms.
 - Panel B shows regression results for the low-attention subset.

1. Procedure to identify earnings announcement dates and times

IBES and Compustat are the two most widely used databases to identify earnings announcement dates. We begin with the HFT sample of 120 stocks, identify their earnings

announcements dates from IBES, and match these announcements in Compustat. This gives us 960 announcements, 937 (98%) of which have the same date in both databases. We delete two announcements where the dates in the two databases are more than 30 days apart. For the remaining 21 unmatched announcements, we verify the correct announcement date manually by examining company press releases and newswire reports. This gives us a sample of 958 earnings announcements (937 initially matched plus 21 verified by news sources).

DeHaan, Shevlin, and Thornock (2015) suggest that some mixed results in the earnings literature may be attributable to challenges in identifying the precise time of announcements. Bradley, Clarke, Lee, and Ornathanalai (2014) find that IBES timestamps are not always accurate. Since our study relies on announcement times in addition to their dates, we use two additional sources to verify the announcement times: Wall Street Horizon (WSH), which provides institutional traders with corporate event data, and Factiva, a leading source of business newswires. Of the 958 announcements in our sample, 781 (82%) have the same date and time in WSH and IBES/Compustat. There are nine earnings announcements that are either not covered by WSH or have different dates in WSH and IBES/Compustat. We verify the date for these announcements using Factiva. For another 168 announcements, the dates match in WSH and IBES/Compustat but the reported times differ by one minute or more. For these cases we use Factiva to verify the announcement time. For 130 of these announcements Factiva agrees with the WSH or IBES/Compustat time, and we use that time. For the remaining 38 announcements, we use the earliest timestamp among Factiva, WSH, and IBES/Compustat as the announcement time. We thus arrive at timestamps for all 958 of the earnings announcements in the sample as filtered so far.

We impose the following additional filters to arrive at our final sample: (i) exclude one announcement made on a non-trading day; (ii) exclude two announcements with no trading in the

HFT dataset; (iii) exclude four stocks with no trading after announcement time on any of their earnings announcement dates; (iv) exclude 13 stocks that have no HFT after announcement time on any of their announcement dates; (v) exclude 75 announcements with no trades after their announcement time. After imposing these filters, we are left with 103 stocks and 745 earnings announcements. These 103 stocks have over 542 million trades, for a total volume exceeding 105 billion shares and a dollar volume of about \$3.9 trillion in 2008-2009.

2. Instrumental Variable (IV) procedure

Conditional on having a valid instrument for HFT participation, we can consistently estimate the effect of HFT participation on price efficiency by following the three-stage methodology outlined in Adams, Almeida, and Ferreira (2009), who have a binary endogenous variable, as we do. The three-stage procedure is as follows. In the first stage, we estimate a binary response model (logit) for the determinants of HFT participation. In the second stage, we regress our HFT indicator on the predicted HFT variable from the first stage, the independent variables, and the controls. In the third stage, we substitute the predicted variable from the second stage into our cumulative abnormal return regression, equation (3). As Adams et al. (2009) highlight, this three-stage method is different from the “pseudo-IV” procedure of using the predicted value from the first stage directly in the cumulative abnormal return regression; such an approach (the pseudo-IV) does not guarantee consistency unless the first stage is correctly specified, so standard errors would need to be adjusted. The advantages of the three-stage method include: explicitly taking into account the binary nature of the endogenous variable; not requiring the first-stage binary response model to be properly specified; and producing standard IV standard errors that are asymptotically valid.

3. Additional Results

Table IA-1: Principal Component Analysis results

We construct our Aggregate_PCA, an alternative composite measure of low attention, as the first principal component of five attention proxies: Busy Day, Slow Analyst Speed, Low EDGAR, High News Distraction, and Friday. Key statistics of the principal component analysis are provided. The results show the first component accounts for 25% of the total variance. The rotated factor pattern demonstrates simple structure. The variables have high loading on one component and low loadings on the other two.

Observations				
Number of Records Read	566			
Number of Records Used	566			
N for Significance Tests	566			
Means and Standard Deviations				
Variable	Mean	Std. Dev.		
Busy day	0.456	0.498		
Slow Analyst Speed	0.451	0.498		
Low EDGAR	0.514	0.5		
High News Distraction	0.493	0.5		
Friday	0.078	0.268		
Eigenvalues of the Correlation Matrix				
	Eigenvalue	Difference	Proportion	Cumulative
1	1.272	0.15	0.254	0.254
2	1.122	0.145	0.224	0.479
3	0.977	0.123	0.195	0.674
4	0.854	0.077	0.171	0.845
5	0.776		0.155	1
Rotated Factor Pattern				
	Factor 1	Factor 2	Factor 3	
Busy day	0.256	-0.704	-0.083	
Slow Analyst Speed	0.005	-0.069	0.948	
Low EDGAR	0.804	0.158	0.176	
High News Distraction	0.197	0.743	-0.157	
Friday	-0.665	0.273	0.25	
Variance Explained by Each Factor				
	Factor1	Factor2	Factor 3	
	1.193	1.152	1.024	
Final Communality Estimates: Total = 3.370				
Busy day	0.569			
Slow Analyst Speed	0.904			
Low EDGAR	0.702			
High News Distraction	0.615			
Friday	0.58			

Table IA-2: Characteristics of stocks with earnings announcements meeting attention-related criteria

The first two panels of this table present mean characteristics of stocks identified as having earnings announcements with low attention and high earnings surprises (Panel A) and stocks having earnings announcements with low attention, high earnings surprise, and HFT trading (Panel B). *Price*, *Trading volume* and *Relative bid-ask spread* are averaged from the prior to current earnings announcement for each earnings announcement and then averaged for each stock. *# Earnings announcements* is the average number of earnings announcements meeting the criteria in each panel, averaged across the stocks with some earnings announcements falling in the panel's category. Panel C presents *p*-values for the differences between values in Panel A and Panel B.

Panel A: Stocks with Low Attention and High Unexpected Earnings (LowAttn*HighUE = 1)

<i>Low Attention proxy</i>	Aggregate	Busy Day	Slow Analyst Speed	High News Distraction	Low EDGAR
Market capitalization (\$ billion)	31.50	16.99	18.94	27.01	24.78
Market-to-book ratio	2.63	2.84	2.44	3.10	2.78
Price	32.54	32.41	32.21	43.61	37.17
Trading volume (shares million)	4.03	2.09	2.32	3.25	3.00
Relative bid-ask spread (bps)	14.45	16.50	15.14	12.91	14.96
# Earnings announcements	1.95	2.52	2.12	2.46	2.24
# Analysts	14.76	11.39	11.76	13.29	12.89

Panel B: Stocks with Low Attention, High Unexpected Earnings, and HFT trading (LowAttn*HighUE*HFT = 1)

<i>Low Attention proxy</i>	Aggregate	Busy Day	Slow Analyst Speed	High News Distraction	Low EDGAR
Market capitalization (\$ billion)	32.26	18.62	19.55	28.17	26.63
Market-to-book ratio	2.58	2.95	2.45	3.12	2.84
Price	32.67	34.05	32.54	44.99	38.07
Trading volume (shares million)	4.15	2.25	2.40	3.38	3.22
Relative bid-ask spread (bps)	14.39	16.13	14.93	12.16	15.01
# Earnings announcements	1.82	2.47	1.98	2.47	2.10
# Analysts	15.03	11.30	11.93	13.34	13.08

Panel C: *p*-values of differences between Panel A and Panel B

<i>Low Attention proxy</i>	Aggregate	Busy Day	Slow Analyst Speed	High News Distraction	Low EDGAR
Market capitalization (\$ billion)	0.9367	0.7920	0.9246	0.8743	0.7893
Market-to-book ratio	0.9172	0.8128	0.9784	0.9620	0.8849
Price	0.9796	0.8256	0.9478	0.9045	0.9306
Trading volume (shares million)	0.9279	0.8330	0.9202	0.8916	0.8382
Relative bid-ask spread (bps)	0.9859	0.8478	0.9066	0.6262	0.9812
# Earnings announcements	0.6071	0.8541	0.5782	0.9839	0.5459
# Analysts	0.8858	0.9555	0.9000	0.9747	0.9035

Table IA-3: HFT internal margin and price efficiency

This table presents multivariate tests of price efficiency with versus without HFTs. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* on earnings announcement days *t* and *t+1* in Panel A and day *t+2* to *t+45* in Panel B. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category under the Aggregate measure, which reflects the combined distribution of Friday, Busy Day, Slow Analyst Speed, High News Distraction, and Low EDGAR earnings announcements. *HFT^{IM}* is the percentage of trading volume executed by HFTs in the remainder of the day following the earnings announcement; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization, firm size indicator variables, percentage bid/ask spread, number of analysts, earnings surprise volatility over the prior four years, and month and year indicators. All controls are also interacted with HighUE. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual LowAttention, HighUE, and HFT variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: Short-term price efficiency			
	Dependent variable = CAR on earnings announcement days <i>t</i> to <i>t+1</i>		
	Small Firms	Medium Firms	Large Firms
Low Attention * HighUE	0.144 (0.213)	-0.099 * (0.070)	-0.070 ** (0.029)
Low Attention * HighUE * HFT ^{IM}	0.710 * (0.064)	0.471 ** (0.034)	0.212 ** (0.027)
All individual variables and combinations	yes	yes	yes
Controls (Interacted)	yes	yes	yes
# Observations	103	171	292

Panel B: Long-term price efficiency			
	Dependent variable = CAR on earnings announcement days <i>t+2</i> to <i>t+45</i>		
	Small Firms	Medium Firms	Large Firms
Low Attention * HighUE	0.346 * (0.069)	0.092 (0.149)	-0.005 (0.901)
Low Attention * HighUE * HFT ^{IM}	-1.872 ** (0.032)	-0.875 *** (0.004)	0.117 (0.212)
All individual variables and combinations	yes	yes	yes
Controls (Interacted)	yes	yes	yes
# Observations	103	171	292

Table IA-4: Internal margin and price efficiency, using abnormal HFT measure

This table presents multivariate tests of price efficiency for earnings announcements with HFT participation measured as abnormal HFT volume. The dependent variable is the cumulative abnormal return (CAR) for stock i on earnings announcement days t to $t+1$ in the first column and day $t+2$ to $t+45$ in the second column. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category under the Aggregate measure, which reflects the combined distribution of Friday, Busy Day, and Slow Analyst Speed announcements. HFT^{Abn} is equal to the HFT percentage of trading following the earnings announcement minus the median HFT percentage during same intraday period from day $t-20$ to day $t-2$. *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years; and month and year indicators. In Panel A, interactions between *HighUE* and the control variables are not included; in Panel B interactions between *HighUE* and the control variables are included. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual *LowAttention*, *HighUE*, and HFT^{Abn} variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: Price efficiency regressions without HighUE*Control interactions

<i>Dependent variable</i>	CAR on earnings announcement days t to $t+1$	CAR on earnings announcement days $t+2$ to $t+45$
Low Attention * HighUE	0.009 (0.558)	0.011 (0.640)
Low Attention * HighUE * HFT^{Abn}	0.038 (0.408)	0.117 (0.277)
HighUE	0.041 *** ($<.001$)	-0.016 (0.271)
HighUE * HFT^{Abn}	-0.022 (0.821)	0.032 (0.752)
All individual variables and combinations	yes	yes
Interacted Controls	no	no
# Observations	501	501

Panel B: Price efficiency regressions with HighUE*Control interactions

<i>Dependent variable</i>	CAR on earnings announcement days t to $t+1$	CAR on earnings announcement days $t+2$ to $t+45$
Low Attention * HighUE	0.009 (0.582)	0.009 (0.719)
Low Attention * HighUE * HFT^{Abn}	0.101 (0.250)	0.109 (0.293)
HighUE	-0.345 (0.399)	-0.178 (0.754)
HighUE * HFT^{Abn}	0.017 (0.866)	0.019 (0.863)
All individual variables and combinations	yes	yes
Interacted Controls	yes	yes
# Observations	501	501

Table IA-5: HFTs and short-term price efficiency with 1-day and 3-day horizons

This table presents multivariate tests of price efficiency with versus without HFTs. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* on earnings announcement day *t* in Panel A and days *t-1* to *t+1* in Panel B. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category given the proxy being used, else zero; *Aggregate* reflects the combined distribution of Friday, Busy Day, Slow Analyst Speed, High News Distraction, and Low EDGAR earnings announcements. *HFT* is equal to one if there is high-frequency trading in the rest of the day following the earnings announcement, else zero; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years and month and year indicators. All controls are also interacted with *HighUE*. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual *LowAttention*, *HighUE*, and *HFT* variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: One-day Cumulative Abnormal Return

<i>Low Attention proxy</i>	Dependent variable = CAR on earnings announcement day <i>t</i>				
	Aggregate	Busy Day	Slow Analyst Speed	High News Distraction	Low EDGAR
Low Attention * HighUE	-0.065 *** (0.003)	-0.045 ** (0.022)	-0.041 ** (0.022)	-0.016 (0.383)	-0.028 (0.114)
Low Attention * HighUE * HFT	0.084 *** (<i><.001</i>)	0.031 * (0.068)	0.042 ** (0.014)	0.036 ** (0.041)	0.029 * (0.070)
Controls (Interacted)	yes	yes	yes	yes	yes
# Observations	566	679	597	679	642

Panel B: Three-day Cumulative Abnormal Return

<i>Low Attention proxy</i>	Dependent variable = CAR on earnings announcement days <i>t-1</i> to <i>t+1</i>				
	Aggregate	Busy Day	Slow Analyst Speed	High News Distraction	Low EDGAR
Low Attention * HighUE	-0.127 ** (0.017)	-0.103 ** (0.021)	-0.163 *** (<i><.001</i>)	-0.004 (0.938)	-0.060 (0.184)
Low Attention * HighUE * HFT	0.150 *** (0.004)	0.072 * (0.052)	0.163 *** (<i><.001</i>)	0.036 (0.259)	0.068 * (0.075)
Controls (Interacted)	yes	yes	yes	yes	yes
# Observations	566	679	597	679	642

Table IA-6: HFTs and long-term price efficiency with 30-day horizon

This table presents multivariate tests of price efficiency with versus without HFTs. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* from 2 days after earnings announcement day *t* to 30 days after. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category given the proxy being used, else zero; *Aggregate* reflects the combined distribution of Friday, Busy Day, Slow Analyst Speed, High News Distraction, and Low EDGAR earnings announcements. *HFT* is equal to one if there is high-frequency trading in the rest of the day following the earnings announcement, else zero; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years and month and year indicators. All controls are also interacted with HighUE. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual LowAttention, HighUE, and HFT variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Dependent variable = Cumulative abnormal return (CAR) on post-earnings-announcement days <i>t+2</i> to <i>t+30</i>					
<i>Low Attention proxy</i>	<i>Aggregate</i>	<i>Busy Day</i>	<i>Slow Analyst Speed</i>	<i>High News Distraction</i>	<i>Low EDGAR</i>
Low Attention * HighUE	0.116 ** (0.032)	0.045 (0.353)	0.12 ** (0.027)	0.085 * (0.084)	0.117 ** (0.023)
Low Attention * HighUE * HFT	-0.096 ** (0.046)	-0.072 * (0.076)	-0.147 *** (0.005)	-0.084 ** (0.050)	-0.085 * (0.059)
Controls (Interacted)	yes	yes	yes	yes	yes
# Observations	566	679	597	679	642

Table IA-7: HFTs and price efficiency under alternative high-frequency trading cutoffs

This table presents multivariate tests of price efficiency with versus without HFTs using two alternative cutoff points. Panel A indentifies events with HFT trading if high-frequency trading exceeds 5% of trading volume. Panel B indentifies events with HFT trading if HFTs trade within 2 hours from earnings announcement time. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* on earnings announcement days *t* and *t+1* in the first column and day *t+2* to *t+45* in the second column. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category under the Aggregate measure, which reflects the combined distribution of Friday, Busy Day, Slow Analyst Speed, High News Distraction, and Low EDGAR earnings announcements. *HFT*^{5%} is equal to one if HFT trading exceeds 5% of trading volume after earnings announcement time for stock *i* on earnings announcement day *t*, else zero; *HFT*^{2hour} is equal to one if HFTs trade within 2 hours from earnings announcement time for stock *i* on earnings announcement day *t*, else zero; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years and month and year indicators. All controls are also interacted with HighUE. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual LowAttention, HighUE, and HFT variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: HFTs trade more than 5% of the trading volume

<i>Dependent variable</i>	CAR on earnings announcement days <i>t</i> to <i>t+1</i>	CAR on earnings announcement days <i>t+2</i> to <i>t+45</i>
Low Attention * HighUE	-0.091 ** (0.038)	0.170 *** (<.001)
Low Attention * HighUE * HFT ^{5%}	0.104 ** (0.017)	-0.172 *** (0.001)
Controls (Interacted)	yes	yes
# Observations	566	566

Panel B: HFTs trade within 2 hours after announcement time

<i>Dependent variable</i>	CAR on earnings announcement days <i>t</i> to <i>t+1</i>	CAR on earnings announcement days <i>t+2</i> to <i>t+45</i>
Low Attention * HighUE	-0.048 * (0.084)	0.080 (0.123)
Low Attention * HighUE * HFT ^{2hour}	0.059 ** (0.026)	-0.073 * (0.095)
Controls (Interacted)	yes	yes
# Observations	566	566

Table IA-8: HFTs and price efficiency using alternative unexpected earnings measure

This table presents multivariate tests of price efficiency with versus without HFTs. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* on earnings announcement days *t* and *t+1* in the first column and days *t+2* to *t+45* in the second column. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category under the *Aggregate* measure, which reflects the combined distribution of Friday, Busy Day, Slow Analyst Speed, High News Distraction, and Low EDGAR earnings announcements. *HFT* is equal to one if there is high-frequency trading in the rest of the day following the earnings announcement, else zero; *HighSUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years and month and year indicators. All controls are also interacted with HighSUE. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual LowAttention, HighSUE, and HFT variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

<i>Dependent variable</i>	CAR on earnings announcement days <i>t</i> to <i>t+1</i>	CAR on earnings announcement days <i>t+2</i> to <i>t+45</i>
Low Attention * HighSUE	-0.097 * (0.052)	0.118 * (0.064)
Low Attention * HighSUE * HFT	0.121 ** (0.012)	-0.152 *** (0.009)
Controls (Interacted)	yes	yes
# Observations	568	568

Table IA-9: HFTs and price efficiency using Aggregate Percentile proxy

This table presents multivariate tests of price efficiency with versus without HFTs. The dependent variable is the cumulative abnormal return (*CAR*) for stock *i* on earnings announcement days *t* to *t+1* in Column (1) and days *t+2* to *t+45* in Column (2). *Low Attention* is determined by the Aggregate Percentile proxy, which is equal to one for an earnings announcement if the average of the quarterly-ranked percentiles of Busy Day, Analyst Speed, News Distraction, and EDGAR is higher than the quarterly median, else zero. *HFT* is equal to one if there is high-frequency trading in the remainder of the day following the earnings announcement, else zero; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years; and month and year indicators. All controls are also interacted with HighUE. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual LowAttention, HighUE, and HFT variables and their other interactions, intercept, controls, and interacted controls are not reported. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

<i>Dependent variable</i>	(1) CAR on earnings announcement days <i>t</i> to <i>t+1</i>	(2) CAR on earnings announcement days <i>t+2</i> to <i>t+45</i>
Low Attention * HighUE	-0.139 *** (<i><.001</i>)	0.150 ** (<i>0.028</i>)
Low Attention * HighUE * HFT	0.143 *** (<i>0.001</i>)	-0.157 ** (<i>0.014</i>)
Controls (Interacted)	yes	yes
# Observations	566	566

Table IA-10: HFTs and price efficiency without interacted controls and for low-attention subset

This table presents multivariate tests of price efficiency for earnings announcements with versus without HFTs. The dependent variable is the cumulative abnormal return (CAR) for stock i on earnings announcement days t to $t+1$ in the first column and day $t+2$ to $t+45$ in the second column. *Low Attention* is equal to one if the earnings announcement falls into the low-attention category under the Aggregate measure, which reflects the combined distribution of Friday, Busy Day, and Slow Analyst Speed announcements. *HFT* is equal to one if there is high-frequency trading in the remainder of the day following the earnings announcement, else zero; *HighUE* is equal to one if the announcement has above-median unexpected earnings, else zero. Regressions also include as controls market capitalization; firm size indicator variables; percentage bid-ask spread; number of analysts; earnings surprise volatility over the prior four years; and month and year indicators. Controls are not interacted with HighUE in these specifications. Coefficients for selected interactions of interest are reported in the table. Coefficients for the individual *LowAttention*, *HighUE*, and *HFT* variables and their other interactions, intercept, and controls are not reported. Panel A includes all observations; Panel B includes only the low attention observations. P-values (reported in parentheses below coefficient estimates) are based on standard errors that are clustered by announcement day. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: Price efficiency regressions without HighUE*Control interaction terms

<i>Dependent variable</i>	CAR on earnings announcement days t to $t+1$	CAR on earnings announcement days $t+2$ to $t+45$
Low Attention * HighUE	-0.145 *** (0.002)	0.179 *** (0.003)
Low Attention * HighUE * HFT	0.157 *** (0.001)	-0.168 *** (0.003)
HighUE	0.080 *** (0.002)	-0.048 (0.235)
HighUE * HFT	-0.040 (0.141)	0.036 (0.394)
All individual variables and combinations	yes	yes
Interacted Controls	no	no
# Observations	566	566

Panel B: Price efficiency regressions using low attention subsample

<i>Dependent variable</i>	CAR on earnings announcement days t to $t+1$	CAR on earnings announcement days $t+2$ to $t+45$
HighUE	-0.058 (0.147)	0.180 *** (<.001)
HighUE * HFT	0.110 *** (0.005)	-0.191 *** (<.001)
HFT	-0.039 * (0.094)	0.123 *** (0.005)
All individual variables and combinations	yes	yes
Interacted Controls	no	no
# Observations	160	160

References

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