TRADING VENUE PREFERENCE: CRITICAL ROLE OF INSTITUTIONAL OWNERSHIP

Le Zhao[1], Vinh Huy Nguyen[2], Suchismita Mishra[3]

ABSTRACT

Using earnings announcements as the reoccurring, scheduled event and share repurchase announcements as the non-reoccurring, unscheduled event, we find that traders strategically choose off-exchange venues around scheduled events. We study and confirm that the scheduled events have higher information asymmetry, which appears to cause traders to route their orders to off-exchange venues. This preference is most prevalent for firms with high institutional ownership. We also find that traders do not show a preference for either venue around unscheduled events. Our findings are robust even during the COVID-19 pandemic.

JEL Classification: G10, G14

Keywords*:* earnings announcements, share repurchase, off-exchange trading, COVID-19

Word count: 11,517

[1] Ph.D. Candidate, Florida International University, College of Business Administration, 11200 S.W. 8th Street RB 204BA, Miami, Florida 33199, lzhao006@fiu.edu, 305-348-2680

[2] Assistant Professor, California State University, Fresno, Craig School of Business, 5245 N Backer Ave. M/S PB 7, Fresno, CA 93740, VinhN@csufresno.edu, 559-278-8214

[3] Professor, Florida International University, College of Business Administration, 11200 S.W. 8th Street RB 204BA, Miami, Florida 33199, mishras@fiu.edu, 305-348-4282

INTRODUCTION

Traders incur certain costs to acquire proprietary information, and how they use that newly acquired knowledge to rebalance their portfolios matters. The timing of their trades and the selected trade venue can materially affect the success of their strategy. More recently, both institutional and retail traders have used off-exchange trading venues to rebalance their holdings for the advantages they offer traders. Foley and Putnins [16] explain that dark pools, a type of off-exchange trading, have lower costs, less information leakage, and, most advantageously, larger orders can avoid being front-run. The ability to hide their orders, which effectively means information, allows traders to earn a higher profit [8] because they can get better prices [17]. However, these benefits come at a cost. Orders sent to dark pools are less likely or take longer to execute [34], [17]. Hence, traders have to balance their needs to manage price impact and execution immediacy [25].

One of the factors that can affect routing preference for either off-exchange venues or the lit market is the expectation of information release, which is the focus of our study. In our research, we examine how trade routing preferences change around two very different firm-level event types: scheduled and unscheduled events. We believe the nature of the scheduled and unscheduled events should have different impacts on order routing decisions. Scheduled announcements, such as earnings announcements, are associated with higher information asymmetry [22], [14] because not all traders can interpret the information as explained by the authors and not all traders are able to acquire private information before the announcement. Nonetheless, because the timing of earnings announcements is known in advance, informed traders, such as institutional investors, can seek information ahead of the release and wait for the announcement to confirm their privately acquired information. At this time, informed traders would route their orders based on their accessibility and level of confidence regarding the information [8], [33].

Conversely, liquidity traders are keenly aware of the adverse selection cost and are likely to refrain from trading until the information asymmetry is resolved [11]. Furthermore, the results from the previous quarter's earnings can positively or negatively impact the stock price. While there are consensus estimates, the actual earnings are not confirmed until the announcement, which can increase the information asymmetry around the scheduled event. In contrast to scheduled events, unscheduled events, such as share repurchase announcements, are not associated with higher information asymmetry because the event is unexpected, giving fewer opportunities for traders to acquire information ex-ante. Thus, the disparities in privately held information are not as great. Additionally, share repurchase announcements, in general, have a predictable impact on the stock price. Most announcements result in an immediate stock price increase lasting from days to months [26], [21], [23], [27], [5]. Because of the different levels of information asymmetry associated with both event types, we believe traders will have specific preferences depending on the opportunity to gather information ex-ante.

Our research meaningfully extends the complementary work of Chae [11], Crego [14], and Menkveld, Yueshen, and Zhu [25]. Chae [11] explains that information asymmetry before scheduled announcements materially affects trading volume, but trading volume is unrelated to proxies of information asymmetry in the context of unscheduled announcements. Crego [14] suggests that public information releases can worsen the adverse selection problem. Our research confirms that higher information asymmetry still exists with scheduled announcements and that volume share, specifically for off-exchange trading venues, increases around scheduled announcements. Our evidence that traders prefer off-exchange venues around scheduled events is robust at the daily and intraday (1-minute and half-hour frequencies) levels even during the COVID-19 pandemic. Moreover, we find that the level of institutional ownership potentially could be a significant predictor of traders' inclination for using off-exchange trading venues, particularly around scheduled events. Firms with a high level of institutional ownership have more analyst attention, higher trading volume, more traders, and hence more visibility (Schwartz and Shapiro, 1992), which makes it more difficult for traders to use their privately acquired information around scheduled events.

Our research also builds on the work of Menkveld, Yueshen, and Zhu [25] by providing additional insights beyond the information urgency shocks from the minute before the event to four minutes post-announcement. Menkveld, Yueshen, and Zhu examine the VIX, macroeconomic data releases, and earnings surprises and find that traders turn to the lit market when there is a positive urgency shock due to these events. In our research, we look at two important corporate events, including earnings announcements, in general, not just the earnings surprises. We also expand the event type to include unscheduled corporate announcements, which differ significantly from the information asymmetry standpoint. Our research also complements theirs from the data perspective. While Menkveld, Yueshen, and Zhu analyze 117 stock transaction activities for one month in 2010, we extend this data to provide a more updated and complete understanding of routing preference. Our data covers all firms that had earnings and repurchase announcements from 2014 to 2020, and the off-exchange volume share is examined under both daily and intraday trading frequency.

The study proceeds as follows. In section 2, we outline our development of the hypotheses. In sections 3 and 4, we describe the data and explain the methodology. Section 5 has our findings, and our concluding remarks are in section 6.

HYPOTHESIS DEVELOPMENT

Accounting for approximately 30% of the equity trading volume, off-exchanges provide traders another option to execute their strategies. Menkveld, Yueshen, and Zhu propose that traders prioritize trading venues based on liquidity, execution certainty, and the value of their proprietary information. According to the authors, the pecking order hypothesis of trading venues states that traders prefer routing to low-cost-low-immediacy venues, such as midpoint dark pools. Traders will switch from dark to lit venues, which are high-cost-high-immediacy venues when there is an information urgency shock. The drop in dark pool volume should be significant. Zhu [34] argues that dark pools are less attractive to informed traders because their trades are less likely to fill. We believe this finding is true if the informed traders all have the same information. The information shock may not have the same impact on traders as they may have heterogeneous expectations depending on the event type.

If there is heterogeneity in information or expectations, off-exchange trading venues may still be useful to traders. Bloomfield, O'Hara, and Saar [8] argue that informed traders can profit using exchanges that allow orders to be partially or fully hidden, but only if the information is of high value. Extending this line of research further, Ye [33] discusses information risk in three levels. If the informed traders have weak signals about a given stock, they will most likely not trade. Those with moderate signals will prefer to route their orders to dark pools to get better pricing because they are less confident about making a profit using such information. Execution is less of a concern. The traders with strong signals prefer higher execution probabilities and will route their orders to lit exchanges as they tend to be more liquid than dark pools. Clearly, trader's routing preferences depends on the quality of the information he or she obtains. This conflict may be especially true around events with different timing. In our study, we examine if routing preference is influenced by two different event types—scheduled and unscheduled.

We use earnings announcements as the scheduled events and share repurchase announcements as the unscheduled events. The timing of these earnings announcements is known in advance, and the event is a reoccurring one allowing traders to acquire private information ex-ante. The opportunity to gather private information before the announcement and confirm that information with the announcement can increase the adverse selection costs for uninformed traders [11], [14]. In contrast, traders do not know if or when the firms will announce share repurchases. As an added level of complexity, traders also do not know if the firms will follow through with actual repurchases. Bhattacharya and Jacobsen [7] find that 24% of the announcing firms do not repurchase shares within the same fiscal year as the announcement, and 13% of the announcing firms do not repurchase shares within four years after the announcement. This lack of

commitment combined with the unscheduled nature of share repurchase announcements can affect the traders' ability to gather information around this type of event. Finally, the two announcement types have different impacts on the stock price. For earnings announcements, if the firm beats expectations, then a price increase is likely to follow, and the reverse is likely to be true if the firm does not exceed estimates. Since traders do not know the results definitively, it is even more critical for them to acquire private information before the earnings announcement, which increases the information asymmetry around the scheduled event.

However, for repurchase announcements, the stock price tends to increase after the event, as documented in the prior studies [26], [21], [23], [27], [5]. Since the result is more predictable for share repurchase announcements, there is less motivation to seek private information. Overall, repurchase announcements do not increase information asymmetry as much when compared to earnings announcements.

Because of all these reasons, we believe that traders may have different routing preferences depending on the event type. In the case of earnings announcements, there is higher information asymmetry because informed traders would prefer to reveal their information only after they have recuperated the information acquisition cost and executed their strategy. This is more likely to happen with off-exchange trading. As for share repurchase announcements, the unexpected nature of the event does not allow traders to plan before the event and eliminates the need to hide any proprietary information using alternative exchanges.

Hypothesis #1: Routing preference for off-exchange trading venues is influenced by scheduled events, but it is not influenced by unscheduled events

Next, we explore the driving forces behind the order routing preferences in our second hypothesis. We believe that the preference for off-exchange trading around scheduled events may be moderated by institutional ownership. Beside analyzing institutional ownership, we also consider the analyst forecast dispersion [9] as proxy for the disagreement. The overall difference between high and low dispersion for off-trading volume share are insignificant around both scheduled and unscheduled events. We also tested the market risk exposure (beta) as the potential driving force for the routing decision. Again, the results are insignificant.

First, as discussed in many previous papers, institutional investors are considered sophisticated investors, and in general, they have more information advantages than other market participants [19], [15], [31], [32] [12], [2], [9] and [6]. In Ali et al. [1] and Campbell, Ramadorai, and Schwartz [10] they find that institutional investors tend to trade aggressively around earnings announcements, especially to exploit mispricing. Therefore, we believe institutional investors may trade in off-exchange venues to maintain their information advantage. Second, as off-exchange trading venues may have lower liquidity than the lit exchanges, traders with proprietary information may find difficulties filling their orders. Rubin [28] explains that the liquidity of a firm's stock is positively related to total institutional holdings. The liquidity comes from the institution's higher trading activity, which reveals information and provides other traders opportunities to rebalance their portfolios. Hence, when traders want to rebalance their holdings of stocks with high institutional ownership, they potentially could do so off-exchange because these stocks are more liquid. Routing to dark could be complementary to a dynamic order-splitting strategy to rebalance portfolios [13] as it also does not reveal too much information while lowering the cost of trading. With higher liquidity in the off-exchange trading venues for higher institutional ownership stocks, more traders may prefer routing their orders away from the lit exchanges to protect their proprietary information.

Hypothesis #2: The level of institutional ownership affects the trading venue preference around firm scheduled events

4

In our last set of tests, we examine if trading preference changes during crisis time, such as during the COVID-19 pandemic. Thaler and Johnson [30] find that traders are less likely to take on risks when they experience consecutive losses. Malmendier and Nagel [24] suggest that dramatic experiences, such as the Great Depression of the 1930s, can permanently impact investors' perceptions and risk-taking behavior. Interestingly, during the volatile October 1997 period, traders withdrew from the electronic market and routed their orders to the floor [18]. From these studies, we are motivated to understand if traders may have reconsidered how they route their orders in times of crisis and volatility. We focus our attention on the COVID-19 pandemic because it is a unique event that caused the local, state, and federal governments to place not only social but also economic restrictions. These restrictions affect the stock market significantly more than previous health crises in 1918–1919, 1957–1958, and 1968 [4]. In terms of the pandemic affecting the stock market liquidity, Haroon and Rizvi [21] find that the number of COVID-19 infection and death rates are inversely related to the stock market liquidity of emerging markets.

Even though our understanding of the impacts of the pandemic is limited, we do know much more about the persistent behavior of traders. We believe that during times of crisis traders will be reluctant to use lit markets especially if they have proprietary information. Information acquisition is costly, and we hypothesize that the COVID-19 pandemic should not impact their preference to route off-exchange around scheduled events.

Hypothesis #3: The COVID-19 pandemic does not change routing preferences around scheduled and unscheduled events. Traders still prefer to route their orders to off-exchange venues around scheduled events, and they do not change preference for either off-exchange or lit markets around unscheduled events.

DATA

Our analysis is based on daily individual National Market System (NMS) stock-level data in regular trading hours (9:30 am - 4:00 pm) from NYSE Daily Trade and Quote (DTAQ) database. We test firm earnings announcements as the scheduled events and repurchase announcements as the unscheduled event. The firm announcements are obtained from two databases: the dates of the earnings announcement are from IBES, and the repurchase announcement dates are from Thomson Reuters SDC. The institutional ownership data is from SEC form 13F. We also obtain data from CRSP, COMPUSTAT, and IBES for control variables such as firm size, SIC codes, analyst coverage. A detailed list of the variables and their descriptions is included in Appendix I. Table 1 summarizes the caveats discussed below.

We only include firms that had both earnings and repurchasing announcements from 2014 to 2019. Our final sample consists of 1,002 firms with 20,150 earnings announcement events and 1,479 repurchase announcement events. Panel A of Table 1 presents our main variable of interest, *Off-exchange Trading Volume Share*, which is calculated as the total volume that is executed in an off-exchange trading venue divided by the overall trading volume for the given time interval. The average proportion of off-exchange trading volume is around 33.0% using a daily interval, 31.3% using a 30-minute interval, and 29.3% using a 1-minute interval. Panel B of Table 1 reports the summary statistics for our main control variables, and Panel C and D of Table 1 reports the number of events in each month of the sample periods. The number of earnings announcements by month in Panel C shows a clear seasonal pattern. Earnings are announced in February for the first quarter, April/May for the second quarter, July/August for the third quarter, and Oct/Nov for the fourth quarter. On the other hand, Panel D suggests that repurchase announcements do not follow any seasonal patterns. The number of repurchase announcements is equally distributed across months.

Table 1. Descriptive Statistics for Earnings and Share Repurchase Announcements

This table provides information on the statistical attributes of the variables used in this paper. Panel A shows the characteristics of the dependent variables, the proportion of off-exchange trading volume for the daily, 30-minute, and 1-minute intervals of 1,002 firms from January 2014 to June 2020. The events are matched by firm and date. Panel B provides a statistical summary of the control variables reported as daily frequency, all control variables are winsorized at 1% and 99% level. Panel C and Panel D show the number of earnings and repurchase announcements used in our sample for each month.

Variable	# of Observations	Mean	Median	Std.Dev.	Min	Max
Panel A: Proportion of off-exchange trading volume						
Daily Interval	334,742	0.330	0.310	0.129	0.00	1.00
30-minutes Interval	6,487,102	0.313	0.281	0.186	0.00	1.00
1-minutes Interval	6,639,370	0.293	0.169	0.334	0.00	1.00
Panel B: Control variables						
Institutional Ownership (%)	334,742	0.369	0.282	0.352	0.000	1.000
Firm Size (in millions)	334,742	12.936	2.526	31.216	0.033	211.053
Price ($)	334,742	50.009	34.520	48.790	1.780	270.320
Turnover	334,742	8.261	6.040	7.713	0.253	45.991
Spread	334,742	0.032	0.010	0.053	0.010	0.370
Analyst Coverage	334,742	10.241	8.00	7.882	1.00	33.00
Volatility	334,742	0.034	0.026	0.029	0.000	1.401
VIX	334,742	14.818	13.860	3.829	9.140	40.740

Panel C: Number of Earnings Announcement Events in Our Sample

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	256	421	133	417	398	44	496	320	52	488	334	62
2015	284	446	156	479	365	49	481	346	53	449	371	63
2016	250	493	137	420	404	48	419	391	46	404	388	52
2017	241	451	147	363	440	53	377	405	43	399	382	50
2018	234	448	143	357	419	48	382	381	37	421	329	52

2019	246	425	122	358	388	44	407	326	44	428	293	52
All years	1,511	2,684	838	2,394	2,414	286	2,562	2,169	275	2,589	2,097	331

Panel D: Number of Repurchase Announcement Events in Our Sample

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	39	58	33	33	54	31	43	40	32	48	47	59
2015	37	64	47	26	27	24	19	22	23	19	35	23
2016	27	30	16	9	23	26	12	9	9	11	22	8
2017	10	19	14	16	16	20	9	12	8	8	18	7
2018	14	17	16	20	11	20	9	9	8	12	13	13
2019	7	13	5	7	5	13	6	3	3	7	5	1
All years	134	201	131	111	136	134	98	95	83	105	140	111

METHODOLOGY

Our main variable of interest is the proportion of off-market trading volume given the designated time intervals. We use both daily and intraday level intervals to test our results. Following Bruch et al. (2017), our event windows for the daily interval include the five days before (Days [-5,-1]), the five days after (Days [+1,+5]), and the day of the announcement (Day [0]). The control window is calculated by averaging the proportion of off-market trading volume by firm in Days [-30, -10]. For the intraday frequency, we test the off-exchange trading volume share under 30-minute and 1-minute intervals for the day before (Day[-1]), the announcement event day (Day[0]), and the day after (Day [+1]) the announcement. We also calculate the steady-state by averaging the proportion of off-market trading volume at event month, excluding Days [-1, +1] and days for other firm's announcements if there are any. To test the effects of institutional ownership on off-exchange trading, we split the firms into three groups based on the proportion of the shares held by institutional investors and categorize them as low-institutional ownership, mid-institutional ownership, and high-institutional ownership stocks.
To test Hypothesis 1, we estimate the following regression model:

$$OffVolShare_{i,t} = \beta_0 + \beta_1 AnnoucementD_{i,t} + \delta X_{i,t} + \epsilon_{i,t} \qquad (1),$$

where i and t indicate a firm and a trading day, respectively. The dependent variable $OffVolShare_{i,t}$ is the off-exchange trading volume share. The key independent variable is the $AnnoucementD_{i,t}$ variable, which takes the value of 1 if t is the announcement day, and 0 otherwise. $X_{i,t}$ is a set of control variables that are used in previous literature to control the heterogeneity of the firm's information environment, including the firm size, price, analyst coverage, quoted spread, firm- and market-level volatility.
Extending the above benchmark specification, the modeling for Hypothesis 2 on the effects of institutional ownership on routing preference around scheduled events is as follows:

$$OffVolShare_{i,t} = \beta_0 + \beta_1 AnnoucementD_{i,t} + \beta_2 AnnoucementD_{i,t} \times IO\_High_{i,t} + \beta_3 IO\_High_{i,t} + \delta X_{i,t} + \epsilon_{i,t} \qquad (2),$$

where $IO\_High_{i,t}$ is the dummy variable that equals one if the firm is in the high-institutional ownership group.

EMPIRICAL RESULTS

Before testing our hypotheses, we examine the information asymmetry of scheduled and unscheduled events using two proxies: the Amihud Illiquidity Measure [3] and the cumulative abnormal log turnover [11]. Both proxies show evidence of higher information asymmetry associated with scheduled events. The results are in Appendix II. With the higher level of information asymmetry confirmed, we can now focus on our main research questions of trade routing preference.

Routing Preference by Scheduled vs. Unscheduled event

Figure 1 shows the average volume share of the off-market trading on the day before, the announcement day, and the day after the announcement using 30-minutes trading intervals. The horizontal dash line is the steady-state value of the average proportion of off-exchange trading volume with no earnings and repurchase announcement. The firm's off-exchange trading volume share is close to its steady-state for both earnings and repurchase announcement on the day before the announcement. Notably, Panel A shows that the off-exchange trading volume shares are significantly higher than the steady-state on the announcement day and the day after the earnings announcement. In contrast, the off-exchange trading volume shares for repurchase announcements in Panel B do not show an uptrend pattern for the announcement day and the day after the announcement. Overall, Figure 1 supports the first hypothesis, suggesting that routing preferences are different for the scheduled and unscheduled events.

Figure 1. The Proportion of Off-Exchange Trading Around Firm Announcements by 30-minutes Interval. This figure plots the volume share of the off-market trading on the day before, the announcement day, and the day after the firm announcements under 30-minutes trading intervals around the earnings announcement (Panel A) and the repurchase announcement (Panel B). The horizontal solid line is the steady-state value of the average proportion of off-exchange trading volume with no earnings and repurchase announcements. The data sample includes off-market trading volume share for 1,002 firms that have both earnings announcements and repurchase announcements between January 2014 and December 2019.

(b) Repurchase Announcement
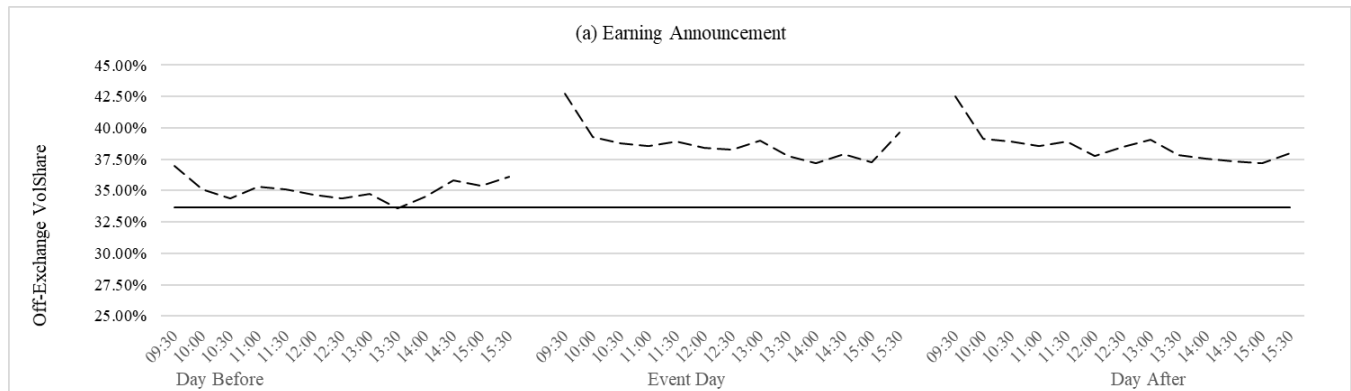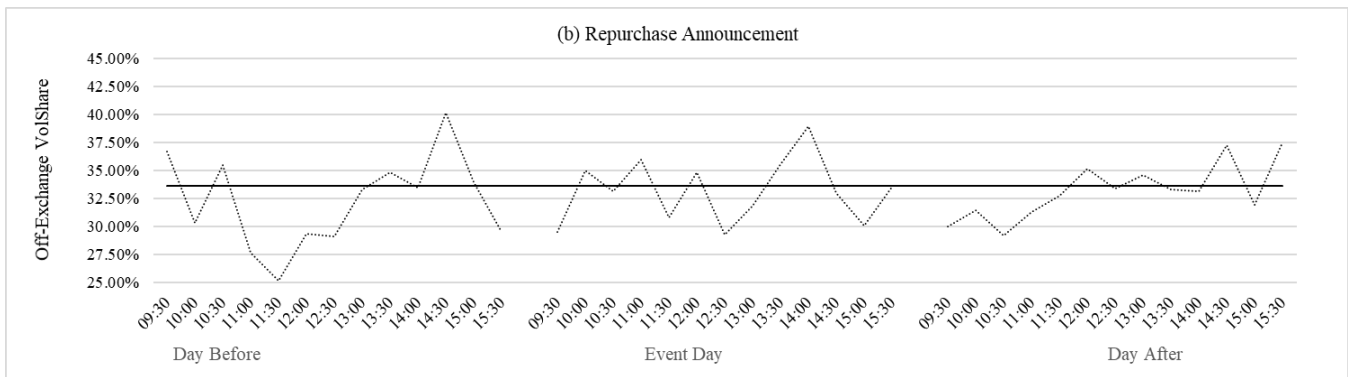
We also examine the proportion of off-exchange trading around firm announcements using a 1-minute interval for the first 15 minutes shown in Figure 2. These patterns are similar to the ones shown in Figure 1. Hence, we believe that routing preferences are different based on the event type.

Figure 2. The Proportion of Off-Exchange Trading Around Firm Announcements by 1-minutes Interval. This figure plots the volume share of the off-market trading on the day before, the announcement day, and the day after the firm announcement using 1-minute trading intervals around the earnings announcement (Panel A) and the repurchase announcement (Panel B). The horizontal solid line is the steady-state value of the average proportion of off-exchange trading volume with no earnings and repurchase announcements. The data sample includes off-market trading volume share for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019.

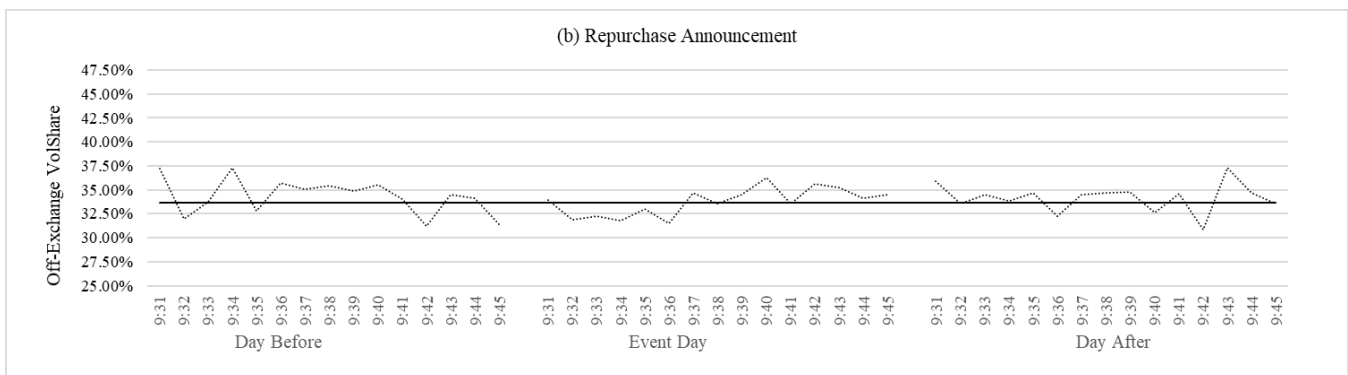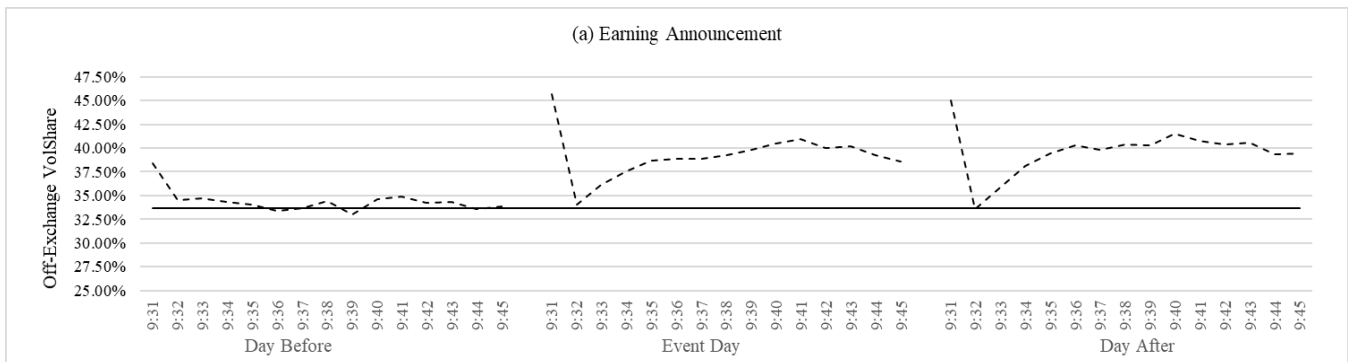(a) Earning Announcement

(b) Repurchase Announcement

Table 2 presents the univariate results to test Hypothesis 1. We apply paired t-test to examine the changes in the off-exchange trading volume on the announcement day compared to the steady-state for the 30-minute trading interval. We also did the paired t-test for the changes in off-exchange trading volume share

9

at day before and after the earnings and repurchase announcement with the steady state. The results are presented in Appendix III and IV. The estimation consists of 1,002 firms with both earnings announcements and repurchase announcements between January 2014 and December 2019. The steady-state off-exchange trading volume is calculated as the average proportion of a firm's off-exchange trading volume given the designated interval with no earnings and repurchase announcement. We report the difference of off-exchange trading volume share using the 30-minute interval in Panel A and 1-minute interval for the first 15 minutes in Panel B.

Table 2. Differences in Off-exchange Trading Volume Share for Firm Scheduled vs. Unscheduled Announcements

This table presents the paired t-test results for the differences in the proportion of off-exchange trading volume share for earnings (scheduled) and repurchase (unscheduled) announcements with the steady-state. Panel A reports the differences in half-hour intervals, and Panel B reports the difference in 1-minute intervals for the first 15 minutes. The sample includes off-market trading volume share for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The steady-state is calculated as the average proportion of the off-exchange trading volume share with no earnings and repurchase announcements. *Diff1* is the difference of off-exchange trading volume share between the day with earnings announcement and the steady-state; *Diff2* is the difference of off-exchange trading volume share between the day with repurchase announcement and the steady-state. Paired t-tests are used to calculate the differences, and t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Panel A: Difference in half-hour interval

Time	Steady State	Earnings Announcement Off-Exchange Trading	Diff 1		Share Repurchase Announcement Off-Exchange Trading	Diff 2	
9:30-10:00	27.08%	33.10%	6.03%	***	27.96%	0.89%	
			(29.04)			(1.31)	
10:00-10:30	33.35%	37.96%	4.62%	***	33.98%	0.63%	
			(21.61)			(0.71)	
10:30-11:00	33.33%	37.26%	3.93%	***	34.31%	0.98%	
			(19.27)			(1.16)	
11:00-11:30	33.78%	37.67%	3.90%	***	34.52%	0.74%	
			(17.84)			(0.81)	
11:30-12:00	33.38%	37.32%	3.94%	***	33.66%	0.27%	
			(18.42)			(0.27)	
12:00-12:30	32.97%	36.62%	3.65%	***	34.85%	1.88%	*
			(15.24)			(1.97)	

Time							
12:30-13:00	32.88%	36.28%	3.40%	***	32.67%	-0.21%	
			(16.31)			*(-0.22)*	
13:00-13:30	32.47%	36.47%	4.00%	***	32.39%	-0.08%	
			(18.76)			*(-0.14)*	
13:30-14:00	33.22%	36.28%	3.06%	***	34.21%	0.99%	
			(14.07)			*(1.26)*	
14:00-14:30	32.97%	35.85%	2.88%	***	33.22%	0.25%	
			(14.06)			*(0.4)*	
14:30-15:00	32.46%	36.11%	3.66%	***	32.75%	0.29%	
			(17.8)			*(0.56)*	
15:00-15:30	31.50%	34.79%	3.29%	***	30.19%	-1.31%	
			(17.23)			*(-1.65)*	
15:30-16:00	26.19%	30.30%	4.11%	***	26.94%	0.75%	
			(24.42)			*(1.55)*	

Panel B: Difference in 1-minute interval

Time	Steady State	Earnings Announcement Off-Exchange Trading	Diff1		Share Repurchase Announcement Off-Exchange Trading	Diff2
9:30-9:31	6.25%	8.50%	2.25%	***	6.31%	0.06%
			(13.56)			*(0.22)*
9:31-9:32	34.21%	34.65%	0.44%		32.38%	-1.83%
			(1.11)			*(-1.09)*
9:32-9:33	32.94%	35.39%	2.45%	***	31.62%	-1.32%
			(6.59)			*(-0.72)*
9:33-9:34	32.20%	35.91%	3.71%	***	30.40%	-1.80%
			(10.01)			*(-1.17)*
9:34-9:35	31.33%	36.02%	4.69%	***	30.78%	-0.55%
			(11.91)			*(-0.33)*
9:35-9:36	29.55%	34.17%	4.63%	***	27.69%	-1.86%
			(12.15)			*(-1.29)*
9:36-9:37	30.17%	34.91%	4.74%	***	31.10%	0.93%
			(11.41)			*(0.76)*
9:37-9:38	30.36%	35.45%	5.09%	***	30.32%	-0.03%

			(12.31)			*(0.17)*
9:38-9:39	30.10%	35.63%	5.53%	***	30.89%	0.79%
			(13.04)			*(0.68)*
9:39-9:40	29.60%	35.59%	6.00%	***	31.92%	2.32%
			(13.49)			*(1.59)*
9:40-9:41	29.29%	35.68%	6.39%	***	29.24%	-0.05%
			(13.93)			*(0.65)*
9:41-9:42	29.79%	35.43%	5.64%	***	31.58%	1.80%
			(12.87)			*(1.45)*
9:42-9:43	30.45%	36.36%	5.91%	***	31.90%	1.45%
			(13.77)			*(1.44)*
9:43-9:44	31.27%	36.52%	5.25%	***	31.73%	0.46%
			(12.19)			*(1.14)*
9:44-9:45	31.53%	36.15%	4.62%	***	32.38%	0.85%
			(10.28)			*(1.51)*

The results in Table 2 strongly support Hypothesis 1. Most of the differences in off-exchange trading volume share for earnings announcements (Diff 1) in both Panel A and Panel B are positively significant at the 0.1% level. The increases in the earnings announcement day off-exchange trading volume share range from 3.06% to 6.03% using the 30-minute interval and from 0.44% to 6.39% using the 1-minute interval. In contrast, the changes in off-exchange trading volume share for repurchase announcements are smaller and statistically insignificant compared to the changes associated with earnings announcements. In summary, Table 2 suggests that the scheduled and unscheduled events have different impacts on traders in routing their orders.

To control the heterogeneity in the firm's information environment and market volatility, we examine the effects of scheduled and unscheduled events on routing preferences by using multivariate regressions. For all regression specifications, we include year-month time fixed effects and the standard errors are double clustered at firm-month level to account for unobserved heterogeneity. Table 3 reports the results of the regression of the daily proportion of off-exchange trading around earnings and repurchase announcements on the event day dummy variable with a set of controls. *EventD* is the variable of interest, which takes the value of 1 if *t* is the announcement day and 0 otherwise. We find the estimated coefficient on *EventD* is positive and statistically significant at the 1% level for earnings announcements and it is insignificant for share repurchase announcements. The significance of coefficients is robust with Huber-White's correction for heteroskedasticity and serial correlation. The coefficient for *EventD* implies that, after controlling for salient firm and market characteristics, the proportion of off-exchange trading volume increases by 2.13% on the earnings announcement day but remains the same on the repurchase announcement day.

Table 3. The Effects of Scheduled vs. Unscheduled Events on Proportion of Off-exchange Trading Volume

This table shows the results of the regression of the daily proportion of off-exchange trading volume share around earnings announcements (Col1) and repurchase announcements (Col2) on the event dummy variable (*EventD*) with a set of controls and year-month fixed effects. *EventD* is the variable of interest, which takes the value of one if *t* is the announcement day and zero otherwise. The sample includes 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The t-statistics are reported in parentheses and are based on the standard errors clustered at the firm-month level. The ***, **, * indicate p-values of 1%, 5% and 10%, respectively. The detailed control variable definitions are provided in Appendix I.

	(1)	(2)
	Earnings Announcement	**Repurchase Announcement**
	OffVolshare	**OffVolshare**
EventD	0.0213***	-0.004
	(26.22)	(-0.92)
Ln(Size)	0.0036***	0.0006
	(4.69)	(0.22)
InvP	0.5376***	0.5407***
	(37.37)	(9.30)
Spread	0.2134***	0.1253*
	(15.32)	(1.82)
Turnover	0.0023***	0.0030***
	(34.73)	(8.84)
Ln(Analyst Coverage)	-0.0101***	-0.0146***
	(-8.03)	(-2.89)
VIX	-0.0031***	-0.0033***
	(-25.15)	(-3.88)
Volatility	0.0480**	-0.0525
	(2.52)	(-0.46)
Constant	0.2899***	0.3433***

	(25.89)		*(8.45)*
Time FE	Yes		Yes
Observations	164,086		6,073
R-squared	0.178		0.184

Next, we analyze whether our findings in Table 3 are supported by examining the intraday trading level volume share. We regress the proportion of off-exchange trading by each 30-minute intraday time segment on the announcement day dummy variable with a set of controls, which include firm size *Ln(Size)*, price *InvP*, quoted spread *Spread*, volume turnover *Turnover*, number of analyst coverage *Ln(Analyst Coverage)*, firm-level trading volatility *Volatility*, and market-level volatility *VIX*. We also include year-month time fixed effect and the standard errors are double clustered at firm-month level. Table 4 presents the results; the estimated coefficients of control variables are not reported for brevity. Panel A shows the coefficient estimates for earnings announcements, and Panel B shows the coefficient estimates for repurchase announcements. Consistent with the findings in Table 3, the *EventD* coefficient estimates are positive and significant at 1% level for earnings announcements shown in Panel A and are insignificant for repurchase announcements shown in Panel B. Collectively, the results in Table 3 and Table 4 support our first hypothesis even after controlling for firm size, spread, turnover, analyst coverage, and volatility. In summary, the results are robust in daily and intraday-trading frequencies after controlling for other variables that may cause the changes in routing venues. Therefore, we postulate that investor's routing preference for off-exchange trading venues is influenced by scheduled events but is not influenced by unscheduled events.

Table 4. The Effects of Scheduled vs. Unscheduled Events on Proportion of Off-exchange Trading Volume in 30-Minute Interval. This table shows the results of the regressions of the proportion of off-exchange trading around firm earnings announcements (Panel A) and repurchase announcements (Panel B) on the event dummy variable with a set of controls and year-month fixed effects by 30 minute intraday time segments. The dependent variable is the proportion of off-exchange trading volume by designated intraday time segment. *EventD* is the variable of interest, which takes the value of one if *t* is the announcement day and zero otherwise. The controls include *Ln(Size)*, *InvP*, *Spread*, *Turnover*, *Ln(Analyst Coverage)*, *Volatility*, and *VIX*. The sample includes 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The t-statistics are reported in parentheses and are based on standard errors clustered at the firm-month level. ***, **, * indicate p-values of 1%, 5% and 10%, respectively. The detailed control variable definitions are provided in Appendix I.

Panel A. Proportion of off-exchange trading volume for earnings announcement

	Event_D	Controls	Time FE	Intercept	Observations	R-squared
9:30-10:00	0.0295***	Yes	Yes	0.0528***	164,086	0.088
	(22.34)			(5.10)		
10:00-10:30	0.0209***	Yes	Yes	0.2285***	164,063	0.072
	(13.78)			(17.06)		
10:30-11:00	0.0183***	Yes	Yes	0.2344***	164,017	0.068
	(12.34)			(17.61)		
11:00-11:30	0.0209***	Yes	Yes	0.2664***	163,963	0.065
	(13.87)			(19.39)		
11:30-12:00	0.0196***	Yes	Yes	0.2311***	163,902	0.060
	(12.86)			(17.51)		
12:00-12:30	0.0159***	Yes	Yes	0.2274***	163,822	0.059
	(10.38)			(16.67)		
12:30-13:00	0.0164***	Yes	Yes	0.2324***	163,721	0.056
	(10.56)			(16.89)		
13:00-13:30	0.0184***	Yes	Yes	0.2345***	163,621	0.056
	(12.19)			(16.96)		
13:30-14:00	0.0164***	Yes	Yes	0.2189***	163,449	0.052
	(10.91)			(16.66)		
14:00-14:30	0.0155***	Yes	Yes	0.2492***	163,306	0.056
	(10.84)			(19.10)		
14:30-15:00	0.0183***	Yes	Yes	0.2488***	163,113	0.058
	(12.71)			(18.57)		

	Event_D	Controls	Time FE	Intercept	Observations	R-squared
15:00-15:30	0.0176***	Yes	Yes	0.2705***	162,931	0.072
	(13.24)			(20.36)		0.134
15:30-16:00	0.0235***	Yes	Yes	0.1876***	162,716	
	(23.76)			(16.93)		
All time segments	0.0193***	Yes	Yes	*0.2214****	2,122,549	0.061
	(26.97)			(20.03)		

Panel B. Proportion of off-exchange trading volume for repurchase announcement

	Event_D	**Controls**	**Time FE**	**Intercept**	**Observations**	**R-squared**
9:30-10:00	0.0010	Yes	Yes	0.1491***	6,073	0.051
	(0.15)			(3.25)		
10:00-10:30	-0.0026	Yes	Yes	0.3402***	6,072	0.074
	(-0.33)			(6.83)		
10:30-11:00	0.0050	Yes	Yes	0.2918***	6,064	0.072
	(0.63)			(5.90)		
11:00-11:30	0.0007	Yes	Yes	0.3498***	6,062	0.074
	(0.09)			(6.97)		
11:30-12:00	0.0012	Yes	Yes	0.3049***	6,060	0.054
	(0.16)			(6.38)		
12:00-12:30	0.0156	Yes	Yes	0.3240***	6,053	0.040
	(1.63)			(6.36)		
12:30-13:00	-0.0029	Yes	Yes	0.2316***	6,045	0.071
	(-0.35)			(5.06)		
13:00-13:30	-0.0101	Yes	Yes	0.2677***	6,034	0.056
	(-1.32)			(5.13)		
13:30-14:00	-0.0006	Yes	Yes	0.2937***	5,997	0.036
	(-0.07)			(5.93)		
14:00-14:30	0.0024	Yes	Yes	0.2574***	5,973	0.054

	(0.31)			*(5.38)*		
14:30-15:00	-0.0033	Yes	Yes	0.2695***	5,958	0.053
	(-0.45)			*(5.53)*		
15:00-15:30	-0.0133*	Yes	Yes	0.2583***	5,944	0.072
	(-1.83)			*(5.94)*		
15:30-16:00	0.0068	Yes	Yes	0.1922***	5,918	0.113
	(1.29)			*(5.01)*		
All time segments	-0.0002	Yes	Yes	0.2669***	76,072	0.054
	(-0.05)			*(7.46)*		

Routing Preference by Institutional Ownership

To try to better understand the mechanism behind the main finding, we test if the preference for using off-exchange trading around scheduled events is moderated by institutional ownership. We first separate firms into three groups based on the proportion of the institutional ownership, and then analyze the changes in off-exchange trading volume share, which is computed as the difference between the average trading volume given the event window and the control window (Days [-30, -10]).

Table 5 reports the changes in off-exchange trading volume share for scheduled versus unscheduled announcements by institutional ownership groups using daily intervals. Panel A shows the descriptive statistics for off-exchange trading volume share by institutional ownership groups. Panel B in Table 4 presents the changes in off-exchange trading volume share around earnings announcements. Overall, Panel B provides preliminary evidence that the changes in off-exchange trading volume share around scheduled announcements could be due to the level of institutional ownership. The off-exchange trading volume share for earnings announcements does not change significantly for stocks with low institutional ownership, and it does increase for stocks with mid- or high institutional ownership. Notably, for stocks with high institutional ownership, the proportion of off-exchange trading starts to increase before the day of the announcement, and the total off-exchange trading volume share increases by 4.86% on the actual earnings announcement day. On the other hand, the changes in off-exchange trading volume share for unscheduled events are not as significant as scheduled events. Panel C in Table 5 shows that the overall changes in off-exchange trading volume share for unscheduled events are not significant for stocks with low- and mid-institutional ownership. Furthermore, the off-exchange trading volume share only increases by 1.56% for stocks with high-institutional ownership on the day of the repurchase announcement. In summary, our overall findings in Table 5 support the second hypothesis, which postulates that high institutional ownership does influence routing preference around scheduled events.

Table 5. Changes in Off-exchange Trading Volume Share for Scheduled vs. Unscheduled Announcements in Daily Interval by Institutional Ownership Group

This table presents univariate results for the off-exchange trading volume share, using daily intervals for earnings and repurchase announcements grouped by the level of institutional ownership. The data sample includes off-market trading volumeshare for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. Panel A reports the statistics summary for off-exchange trading volume share for each institutional ownership group. Each firm is placed into a low, mid, or high institutional ownership group based on the rank of the number of shares held by institutions divided by the number of shares outstanding. Panel B reports the changes in off-exchange trading volume share for earnings announcements and Panel C reports the changes in off-exchange trading volume share for repurchase announcements. The change in off-exchange trading volume share is the difference between the average trading volume given the event window and the control window (Days [-30, -10]). Paired t-tests are used to calculate the differences, and t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels are denoted by *, **, and ***, respectively.

Panel A: Descriptive Statistics for Off-exchange Trading Volume Share in Daily Interval by Institutional Ownership group

Off-exchange Trading Volume Share	Mean	Median	Stdev	Min	Max
Low Institutional Ownership (*LOW*)	37.18%	34.44%	16.69%	0.02%	100.00%
Mid-Institutional Ownership (*MID*)	31.29%	30.20%	10.15%	0.17%	100.00%
High-Institutional Ownership (*HIGH*)	30.57%	29.44%	9.95%	0.38%	100.00%

Panel B: Changes in Off-exchange Trading Volume Share for Earnings Announcement in Daily Interval

Event Window	*LOW*		*MID*		*HIGH*	
Days [-5, -1]	0.52%		0.45%		0.25%	*
	(0.53)		(1.29)		(2.40)	
Day [0]	2.16%		1.94%	***	4.86%	***
	(1.23)		(3.62)		(30.29)	
Days [+1, +5]	1.92%		1.02%	**	1.11%	***
	(1.90)		(2.83)		(10.42)	

Days [-5, +5]	1.28%		0.85%	**	1.07%	***
	(1.62)		(2.94)		(12.38)	

Panel C: Changes in Off-exchange Trading Volume Share for Repurchase Announcement in Daily Interval

Event Window	*LOW*	*MID*	*HIGH*	
Days [-5, -1]	0.57%	0.36%	0.16%	
	(0.48)	(0.68)	(0.80)	
Day [0]	-0.16%	-0.67%	1.56%	***
	(-0.08)	(-0.63)	(5.12)	
Days [+1, +5]	1.51%	0.83%	0.65%	**
	(1.22)	(1.20)	(3.14)	
Days [-5, +5]	0.95%	0.50%	0.51%	**
	(0.92)	(0.96)	(3.18)	

Next, we investigate whether the findings in Table 5 are still valid under the intraday trading level. Table 6 presents the changes in off-exchange trading volume share for the day before, the announcement day, and the day after the earnings and repurchase announcement in 30-minute intervals grouped by institutional ownership. Panel A reports the changes in off-exchange trading volume share for earnings announcement (scheduled announcement) and Panel B reports the results for repurchase announcement (unscheduled announcements). The changes in off-exchange trading volume share using the 30-minute intervals is calculated as the difference between the firm's proportion of the off-exchange trading volume and its trading steady state for the given interval, and the steady state is the average proportion of the off-exchange trading volume with no earnings and repurchase announcements. Overall, the results in Table 6 are statistically similar in Table 5. The order routing preferences are strongly influenced by the proportion of institutional ownership. Stocks with high institutional ownership have higher off-exchange trading volume share around scheduled events than stocks with low institutional ownership.

Table 6. Changes in Off-exchange Trading Volume Share at Earnings and Repurchase Announcements in 30-Minute Interval by Institutional Ownership Group

This table presents univariate results for the changes in off-exchange trading volume share for the day before (Day [-1]), the announcement day (Day [0]), and the day after (Day [+1]) with the steady state for earnings and repurchase announcements grouped by the level of institutional ownership. The steady state is calculated as the average proportion of the off-exchange trading volume share with no earnings and repurchase announcements. *LOW, MID, HIGH* denotes low, mid, and high institutional ownership groups, respectively. Each firm is placed into a low, mid, or high institutional ownership group based on the rank of the number of shares held by institutions divided by the number of shares outstanding. The data sample includes off-market trading volumeshare for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. Panel A reports the changes in off-exchange trading volume share for earnings announcements, and Panel B reports the changes in off-exchange trading volume share for repurchase announcements. Paired t-tests are used to calculate the differences, and the t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Panel A: Changes in Off-exchange Trading Volumeshare in 30 minutes Intervals for Earnings Announcement by the Institutional Ownership Group

Time	LOW								MID								HIGH					
	Day [-1]		Day [0]		Day [+1]				Day [-1]		Day [0]		Day [+1]				Day [-1]		Day [0]		Day [+1]	
9:30-10:00	0.06%		1.20%		4.51%		***		2.26%	***	6.87%	***	6.07%	***			2.39%	***	7.13%	***	6.66%	***
	(0.05)		(1.1)		(4.6)				(6.46)		(16.85)		(16.01)				(12.21)		(33.49)		(30.74)	
10:00-10:30	0.69%		3.43%	*	3.24%		**		1.49%	***	4.85%	***	4.67%	***			1.05%	***	5.28%	***	4.96%	***
	(0.54)		(2.53)		(3.07)				(3.82)		(12)		(11.66)				(5.2)		(23.87)		(26.33)	
10:30-11:00	-1.67%		0.62%		4.52%		***		0.89%	*	4.25%	***	3.94%	***			1.13%	***	4.84%	***	4.68%	***
	(-1.09)		(0.44)		(3.7)				(2.12)		(10.2)		(9.58)				(6.08)		(22.3)		(23.59)	
11:00-11:30	1.42%		2.40%		1.38%				0.93%	*	3.82%	***	4.22%	***			1.09%	***	4.88%	***	4.15%	***
	(1.25)		(1.71)		(1.13)				(2.4)		(9.49)		(9.79)				(5.35)		(22.67)		(21.31)	
11:30-12:00	-0.64%		1.75%		3.14%		**		1.59%	***	4.10%	***	4.07%	***			1.09%	***	4.77%	***	4.25%	***
	(-0.45)		(1.48)		(3.11)				(3.5)		(9.79)		(9.83)				(5.44)		(22.48)		(22.22)	

Time									
12:00-12:30	0.53%	2.63% *	3.00% *	1.33% **	3.76% ***	3.42% ***	1.12% ***	4.26% ***	4.03% ***
	(0.41)	(2.2)	(2.29)	(2.96)	(8.04)	(9.06)	(5.7)	(20.12)	(19.37)
12:30-13:00	0.46%	-0.67%	2.51% *	1.19% **	3.03% ***	3.97% ***	0.86% ***	4.57% ***	3.48% ***
	(0.33)	(-0.49)	(2.35)	(2.7)	(7.8)	(9.36)	(4.37)	(22.11)	(16.71)
13:00-13:30	-0.65%	3.61% **	4.39% ***	1.30% ***	4.77% ***	4.04% ***	1.78% ***	4.43% ***	3.91% ***
	(-0.48)	(3.05)	(3.31)	(3.1)	(12.03)	(10.23)	(7.81)	(21.05)	(17.57)
13:30-14:00	-2.04%	1.36%	2.52% *	0.29%	3.03% ***	3.14% ***	0.96% ***	3.85% ***	2.44% ***
	(-1.34)	(1.15)	(2.16)	(0.63)	(7.51)	(7.95)	(4.91)	(18.68)	(12.92)
14:00-14:30	-1.90%	0.76%	1.45%	1.22% **	3.08% ***	2.76% ***	1.11% ***	3.51% ***	2.76% ***
	(-1.63)	(0.67)	(1.23)	(3.07)	(7.79)	(7.1)	(5.59)	(18.22)	(15.86)
14:30-15:00	0.87%	2.64% **	1.80%	1.43% ***	3.97% ***	2.44% ***	1.45% ***	3.79% ***	2.78% ***
	(0.68)	(2.34)	(1.81)	(3.38)	(10.54)	(6.45)	(7.88)	(18.69)	(14.17)
15:00-15:30	0.26%	1.93%	1.43%	1.71% ***	3.28% ***	2.52% ***	1.60% ***	3.81% ***	2.45% ***
	(0.17)	(1.91)	(1.13)	(4.21)	(8.52)	(6.13)	(9.32)	(21.52)	(13.79)
15:30-16:00	-2.91% **	4.12% ***	3.78% ***	2.38% ***	4.01% ***	2.70% ***	2.38% ***	4.48% ***	2.87% ***
	(-2.86)	(5.31)	(4.19)	(7.15)	(13.32)	(9.58)	(19.29)	(32.52)	(20.79)

Panel B: Changes in Off-exchange Trading Volumeshare in 30 minutes Intervals for Repurchase Announcement by The Institutional Ownership Group

	LOW			MID			HIGH		
Time	Day [-1]	Day [0]	Day [+1]	Day [-1]	Day [0]	Day [+1]	Day [-1]	Day [0]	Day [+1]
9:30-10:00	8.73% *	2.76%	-0.76%	-1.20%	0.07%	3.03%	0.76%	1.31% *	2.33% ***
	(2.12)	(0.71)	(-0.21)	(-0.52)	(0.03)	(1.4)	(1.01)	(1.98)	(3.23)
10:00-10:30	4.53%	2.04%	-3.08%	-4.22%	-2.23%	3.07%	0.32%	0.95%	2.56% ***
	(1.05)	(0.46)	(-0.79)	(-1.64)	(-0.88)	(1.18)	(0.39)	(1.37)	(3.56)
10:30-11:00	5.46%	2.73%	-4.52%	-3.53%	0.85%	1.24%	0.68%	0.83%	1.99% **
	(1.48)	(0.6)	(-0.95)	(-1.48)	(0.32)	(0.43)	(0.81)	(1.07)	(2.62)
11:00-11:30	-0.44%	1.38%	-4.22%	-0.58%	0.04%	0.65%	-0.01%	0.70%	1.47% *
	(-0.13)	(0.37)	(-1.48)	(-0.21)	(0.01)	(0.24)	(-0.01)	(0.98)	(1.96)
11:30-12:00	-4.41%	-8.55% *	-3.57%	-1.29%	2.00%	-0.47%	-0.02%	0.96%	0.95%
	(-0.93)	(-2.15)	(-1.01)	(-0.47)	(0.7)	(-0.16)	(-0.03)	(1.2)	(1.28)
12:00-12:30	-7.30% *	-2.52%	0.04%	-7.86%	3.77%	5.22% *	-0.05%	2.99% *	2.19% **
	(-2.06)	(-0.59)	(0.01)	(-3.2)	(1.19)	(1.99)	(-0.06)	(3.49)	(3.03)
12:30-13:00	3.59%	-1.36%	2.14%	-5.00%	-3.42%	0.15%	0.63%	1.42%	0.65%
	(1.06)	(-0.3)	(0.6)	(-1.9)	(-1.36)	(0.06)	(0.77)	(1.75)	(0.82)
13:00-13:30	4.20%	4.54%	1.59%	-3.08%	-4.41%	1.71%	0.86%	0.63%	1.29%

Time									
	(0.93)	*(1.15)*	*(0.49)*	*(-1.13)*	*(-1.71)*	*(0.61)*	*(0.99)*	*(0.87)*	*(1.63)*
13:30-14:00	-1.94%	1.41%	-6.84%	-1.39%	1.06%	-0.92%	-0.81%	1.46%	1.48%
	(-0.46)	*(0.36)*	*(-1.72)*	*(-0.48)*	*(0.38)*	*(-0.35)*	*(-0.98)*	*(1.75)*	*(1.87)*
14:00-14:30	2.03%	8.70%	-1.02%	-0.91%	-0.39%	2.45%	-0.42%	-0.51%	-0.33%
	(0.49)	*(1.94)*	*(-0.22)*	*(-0.33)* *	*(-0.15)*	*(0.98)*	*(-0.5)*	*(-0.71)*	*(-0.48)*
14:30-15:00	13.12%	10.49%	5.89%	2.34%	-5.75% *	1.79%	0.65%	1.20%	0.72%
	(3.09)	*(2.97)*	*(1.39)*	*(0.84)*	*(-2.27)*	*(0.69)*	*(0.83)*	*(1.6)*	*(1.07)*
15:00-15:30	2.90%	-3.76%	1.08%	-0.54%	-5.01% *	6.13% *	-0.31%	0.02%	2.11% **
	(0.71)	*(-0.84)*	*(0.35)*	*(-0.21)*	*(-2.15)*	*(2.26)*	*(-0.48)*	*(0.02)*	*(2.9)*
15:30-16:00	1.07%	-0.30%	0.06%	-0.39%	1.76%	3.06%	0.66%	0.56%	0.67%
	(0.33)	*(-0.12)*	*(0.02)*	*(-0.25)*	*(0.9)*	*(1.65)*	*(1.26)*	*(1.27)*	*(1.35)*

In Table 7, we apply daily frequency data to regress the proportion of off-exchange trading volume on *EventD* and its interaction term with *IO_High*, a dummy equals one if the firm belongs to high-institutional ownership. To accurately measure this interaction effect, we also control for the *IO_High* dummy and all of the controls specified in Equation (2). The positive and significant coefficient estimates for *EventD* and its interaction term with *IO_High* in column (1) suggest that there is more off-exchange trading for scheduled events; furthermore, the firm with high institutional ownership has higher off-exchange trading on the day of the scheduled announcement than the firm with low institutional ownership. In contrast, the insignificant coefficient estimates for *EventD* and its interaction term with *IO_High* in Table 7 column (2) suggest that the unchanged routing behavior for unscheduled events is not altered by institutional ownership.

Table 7. The Effects of Scheduled vs. Unscheduled Events on Proportion of Off-exchange Trading Volume by Institutional Ownership

This table shows the results of the regression of the proportion of off-exchange trading around firm earnings announcements (Col1) and repurchase announcements (Col2) on the Event dummy variable (*EventD*) with a set of controls including an interaction term between *EventD* and *IO_High*. *EventD* is the variable of interest, which takes the value of one if t is the announcement day and zero otherwise. *IO_High* is a binary variable equal to one if the firm is in the high-institutional ownership group. The sample includes 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The t-statistics are reported in parentheses and are based on the standard errors clustered at the firm-month level. ***, **,* indicate p-values of 1%, 5% and 10%, respectively. The detailed control variable definitions are provided in Appendix I.

	(1) Earnings Announcement OffVolshare	(2) Repurchase Announcement OffVolshare
EventD	0.0145***	-0.0120
	(10.06)	(-1.25)
EventD × IO_High	0.0106***	0.0131
	(6.66)	(1.28)
IO_High	-0.0263***	-0.0383***
	(-18.09)	(-5.67)
Ln(Size)	0.0043***	0.0024

	(5.85)	*(0.89)*
InvP	0.5147***	0.5141***
	(35.42)	*(8.71)*
Spread	0.1961***	0.1151*
	(14.37)	*(1.73)*
Turnover	0.0023***	0.0030***
	(35.81)	*(9.05)*
Ln(Analyst Coverage)	-0.0088***	-0.0108**
	(-7.21)	*(-2.21)*
VIX	-0.0030***	-0.0034***
	(-24.59)	*(-4.16)*
Volatility	0.0509***	-0.0740
	(2.74)	*(-0.65)*
Constant	0.2930***	0.3377***
	(26.88)	*(8.57)*
Time FE	Yes	Yes
Observations	164,086	6,073
R-squared	0.188	0.199

Table 8 presents the regressions of the scheduled (Panel A) and unscheduled event dummy (Panel B) on the proportion of off-exchange trading volume by institutional ownership under the 30-minute interval frequency. Similar to Table 7, we interact *EventD* with *IO_High* to test whether firms with high institutional ownership experience more off-exchange trading on the event day. The results in Table 8 Panel A, consistent with findings in Table 7, suggest that high institutional ownership indeed influences routing preference around scheduled events. Likewise, Panel B shows that the estimates for *Event_D* and the interaction term are insignificant, suggesting that traders do not change their routing preference on the day of the unscheduled event, regardless of the institutional ownership. In summary, our findings in Table 8 are consistent with our findings in Table 5. We find that institutional ownership can significantly impact the order routing around the scheduled event.

Table 8. The Effects of Scheduled vs. Unscheduled Events on Proportion of Off-exchange Trading Volume by Institutional Ownership in 30-Minute Interval

This table shows the results of the regressions of the proportion of off-exchange trading volume share around earnings announcements (Panel A) and repurchase announcements (Panel B) on the Event dummy variable with a set of controls including an interaction term between EventD and IO_High in 30-minute intraday segments. The dependent variable is the proportion of off-exchange trading volume share by the designated intraday time segment. EventD is the variable of interest, which takes the value of one if t is the announcement day and zero otherwise. IO_High is a binary variable equal to one if the firm is in the high-institutional ownership group. Controls include Ln(Size), InvP, Spread, Turnover, Ln(Analyst Coverage), Volatility, and VIX. The sample includes 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The t-statistics are reported in parentheses and are based on the standard errors clustered at the firm-month level. ***, **, * indicate the p-values of 1%, 5% and 10%, respectively. The detailed control variable definitions are provided in Appendix I.

Panel A. Proportion of off-exchange trading volume for earnings announcement

	Event_D	EventD × IO_High	IO_High	Controls	Time FE	Intercept	Observations	R^2
9:30-10:00	0.0245***	0.0079***	-0.0164***	Yes	Yes	0.0548***	164,086	0.089
	(10.23)	(2.92)	(-10.49)			(5.30)		
10:00-10:30	0.0144***	0.0101***	-0.0266***	Yes	Yes	0.2315***	164,063	0.075
	(5.13)	(3.25)	(-14.66)			(17.58)		
10:30-11:00	0.0107***	0.0118***	-0.0261***	Yes	Yes	0.2375***	164,017	0.071
	(3.84)	(3.82)	(-14.58)			(18.07)		
11:00-11:30	0.0128***	0.0126***	-0.0272***	Yes	Yes	0.2697***	163,963	0.069
	(4.61)	(4.09)	(-15.25)			(19.98)		
11:30-12:00	0.0127***	0.0108***	-0.0267***	Yes	Yes	0.2343***	163,902	0.063
	(4.38)	(3.38)	(-14.89)			(18.07)		
12:00-12:30	0.0088***	0.0111***	-0.0266***	Yes	Yes	0.2307***	163,822	0.063

	Event_D	EventD × IO_High	IO_High	Controls	Time FE	Intercept	Observations	R²
	(2.99)	*(3.41)*	*(-14.88)*			*(17.18)*		
12:30-13:00	0.0065**	0.0155***	-0.0248***	Yes	Yes	0.2359***	163,721	0.059
	(2.20)	*(4.81)*	*(-13.98)*			*(17.38)*		
13:00-13:30	0.0128***	0.0086***	-0.0248***	Yes	Yes	0.2375***	163,621	0.059
	(4.53)	*(2.72)*	*(-14.05)*			*(17.42)*		
13:30-14:00	0.0099***	0.0101***	-0.0249***	Yes	Yes	0.2221***	163,449	0.056
	(3.47)	*(3.23)*	*(-14.34)*			*(17.13)*		
14:00-14:30	0.0076***	0.0124***	-0.0252***	Yes	Yes	0.2526***	163,306	0.060
	(2.87)	*(4.19)*	*(-14.76)*			*(19.66)*		
14:30-15:00	0.0157***	0.0038	-0.0247***	Yes	Yes	0.2516***	163,113	0.062
	(5.85)	*(1.29)*	*(-14.60)*			*(19.07)*		
15:00-15:30	0.0121***	0.0085***	-0.0261***	Yes	Yes	0.2739***	162,931	0.077
	(4.86)	*(3.10)*	*(-15.84)*			*(21.03)*		
15:30-16:00	0.0213***	0.0033*	-0.0177***	Yes	Yes	0.1899***	162,716	0.138
	(11.90)	*(1.69)*	*(-13.29)*			*(17.48)*		
All Time Segments	0.0130***	0.0097***	-0.0244***	Yes	Yes	0.2243***	2,122,549	0.064
	(11.22)	*(7.50)*	*(-17.36)*			*(20.75)*		

Panel B. Proportion of off-exchange trading volume for repurchase announcement

	Event_D	EventD × IO_High	IO_High	Controls	Time FE	Intercept	Observations	R²
9:30-10:00	-0.0090	0.0163	-0.0268***	Yes	Yes	0.1457***	6,073	0.055
	(-0.64)	*(1.06)*	*(-3.27)*			*(3.23)*		
10:00-10:30	-0.0091	0.0106	-0.0303***	Yes	Yes	0.3358***	6,072	0.078
	(-0.54)	*(0.59)*	*(-3.41)*			*(6.82)*		
10:30-11:00	0.0097	-0.0077	-0.0316***	Yes	Yes	0.2860***	6,064	0.076

Time Segment								
	(0.56)	(-0.41)	(-3.74)			(5.92)		
11:00-11:30	-0.0030	0.0062	-0.0402***	Yes	Yes	0.3436***	6,062	0.080
	(-0.17)	(0.33)	(-4.81)			(7.02)		
11:30-12:00	-0.0064	0.0124	-0.0351***	Yes	Yes	0.3000***	6,060	0.059
	(-0.37)	(0.67)	(-4.18)			(6.43)		
12:00-12:30	0.0172	-0.0025	-0.0314***	Yes	Yes	0.3187***	6,053	0.044
	(0.81)	(-0.11)	(-3.65)			(6.33)		
12:30-13:00	-0.0206	0.0286	-0.0304***	Yes	Yes	0.2287***	6,045	0.075
	(-1.14)	(1.47)	(-3.60)			(5.07)		
13:00-13:30	-0.0225	0.0201	-0.0391***	Yes	Yes	0.2630***	6,034	0.062
	(-1.36)	(1.11)	(-4.66)			(5.18)		
13:30-14:00	0.0028	-0.0054	-0.0306***	Yes	Yes	0.2886***	5,997	0.040
	(0.16)	(-0.28)	(-3.83)			(5.92)		
14:00-14:30	0.0218	-0.0310*	-0.0223***	Yes	Yes	0.2517***	5,973	0.057
	(1.28)	(-1.71)	(-2.72)			(5.34)		
14:30-15:00	-0.0211	0.0284	-0.0363***	Yes	Yes	0.2660***	5,958	0.059
	(-1.28)	(1.59)	(-4.65)			(5.62)		
15:00-15:30	-0.0331**	0.0319*	-0.0418***	Yes	Yes	0.2543***	5,944	0.081
	(-2.12)	(1.88)	(-5.75)			(6.07)		
15:30-16:00	0.0152	-0.0132	-0.0236***	Yes	Yes	0.1880***	5,918	0.119
	(1.28)	(-1.05)	(-3.95)			(5.01)		
All Time Segments	0.0057	0.009	-0.0326***	Yes	Yes	0.262***	76,072	0.059
	(0.81)	(1.17)	(-5.02)			(7.60)		

Routing Preference under COVID19 Pandemic Period

So far, we have demonstrated that the order routing preference is different under scheduled and unscheduled events. Additionally, the increased trading in off-exchange venues for the scheduled announcement is mainly driven by institutional investors. In this section, we examine Hypothesis 3 to test whether the routing preferences change during crisis time. We focus on the scheduled and unscheduled events during the COVID-19 pandemic period since it affects market liquidity [4] and increases market volatility and uncertainty [1]. We use January 2020 to June 2020 as the event window and examine the routing changes for firms that have earnings and repurchase announcements.

Table 9 reports the findings for the changes in routing venues around earnings announcements under a 30-minute interval in the COVID-19 pandemic period. *Diff1*, *Diff2*, and *Diff3* represent the difference in the off-exchange trading volume share on the day before, the announcement day, and the day after the announcement with the steady state, respectively. Consistent with the previous analysis, the steady state is calculated as the average proportion of off-exchange trading volume share for days without announcement events, given the designated trading time interval. *Diff2* and *Diff3* are positive and strongly significant through all time segments, suggesting that there is more off-exchange trading around scheduled events.

Table 9. Differences in Off-exchange Trading Volume Share for Scheduled Announcements in COVID-19 Pandemic Period

This table presents univariate results for the differences in the proportion of off-exchange trading volume share for earnings announcements with the steady state in half-hour intervals. The data sample includes off-exchange trading volume share for 772 firms with earnings announcements between January 2020 and June 2020. The steady state is calculated as the average proportion of off-exchange trading volume share with no earnings and repurchase announcements by month. *Diff1*, *Diff2*, and *Diff 3* are the off-exchange trading volume share difference for the day before, the announcement day, and the day after the earnings announcement and the steady state, respectively. Paired t-tests are used to calculate the differences, and the t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Time	Steady State	Day Before	Diff1		Event Day	Diff2		Day After	Diff3	
9:30-10:00	26.71%	28.07%	1.36%	***	32.02%	5.31%	***	32.63%	5.93%	***
			(3.37)			(13.13)			(14.51)	
10:00-10:30	34.65%	35.97%	1.31%	**	37.90%	3.25%	***	37.63%	2.98%	***
			(2.71)			(7.23)			(6.61)	
10:30-11:00	33.84%	35.33%	1.49%	**	36.90%	3.06%	***	37.66%	3.82%	***
			(3.23)			(6.73)			(7.99)	
11:00-11:30	34.03%	34.97%	0.94%	*	37.71%	3.68%	***	37.26%	3.23%	***
			(2.05)			(8.38)			(7.11)	

Time			Diff1			Diff2			Diff3	
11:30-12:00	33.53%	34.61%	1.08%	*	36.86%	3.33%	***	37.47%	3.94%	***
			(2.2)			(7.01)			(7.83)	
12:00-12:30	33.73%	34.87%	1.14%	*	36.96%	3.23%	***	37.24%	3.51%	***
			(2.35)			(6.98)			(7.22)	
12:30-13:00	32.76%	34.41%	1.65%	***	35.33%	2.57%	***	35.67%	2.91%	***
			(3.41)			(5.47)			(6.24)	
13:00-13:30	33.18%	34.54%	1.36%	**	36.17%	2.99%	***	36.51%	3.34%	***
			(2.96)			(6.68)			(6.9)	
13:30-14:00	32.97%	33.40%	0.43%		35.40%	2.44%	***	35.58%	2.62%	***
			(0.92)			(5.59)			(5.58)	
14:00-14:30	32.80%	33.79%	0.99%	*	36.16%	3.37%	***	34.91%	2.12%	***
			(2.14)			(7.62)			(4.61)	
14:30-15:00	31.61%	32.59%	0.98%	*	34.41%	2.80%	***	34.90%	3.30%	***
			(2.32)			(6.44)			(7.19)	
15:00-15:30	31.35%	33.19%	1.84%	***	34.04%	2.69%	***	33.35%	2.00%	***
			(4.29)			(6.95)			(4.86)	
15:30-16:00	25.63%	28.18%	2.55%	***	29.20%	3.57%	***	28.79%	3.16%	***
			(8.67)			(12.47)			(11.24)	

Table 10 reports the differences in off-exchange trading volume share around repurchase announcements using 30-minute trading intervals in the COVID-19 pandemic period. Notably, *Diff1* is insignificant across all time segments. Most of *Diff2* and *Diff3* are insignificant, showing that most investors are unaware of the unscheduled event, thereby not strategically switching the routing venues. These results are consistent with those in Tables 2 and 3, again suggesting that the order routing decision is significantly influenced by scheduled events and not influenced by unscheduled events, despite the volatile market environment.

Table 10. Differences in Off-exchange Trading Volume Share for Unscheduled Announcements in COVID-19 Pandemic Period

This table presents univariate results for the differences in the proportion of off-exchange trading volume share for earnings announcements and the steady state by half-hour intervals. The data sample includes off-exchange trading volume share for 150 firms that have earnings announcements between January 2020 and June 2020. The steady state is calculated as the average proportion of off-exchange trading volume share with no earnings and repurchase announcements by month. *Diff1*, *Diff2,* and *Diff3* are the

off-exchange trading volume share difference for the day before, the day of, and the day after the earnings announcement and the steady state, respectively. Paired t-tests are used to calculate the differences, and the t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Time	Steady State	Day Before	Diff1	Event Day	Diff2		Day After	Diff3	
9:30-10:00	30.47%	30.95%	0.49%	21.05%	-9.41%	***	30.15%	-0.32%	
			(0.00)		(-3.33)			(-0.36)	
10:00-10:30	42.39%	45.91%	3.53%	41.73%	-0.65%		42.99%	0.60%	
			(0.02)		(-0.46)			(-0.03)	
10:30-11:00	40.39%	37.79%	-2.59%	39.47%	-0.92%		35.00%	-5.39%	
			(-0.05)		(-0.42)			(-1.44)	
11:00-11:30	40.79%	41.74%	0.95%	42.17%	1.39%		38.95%	-1.83%	
			(-0.01)		(0.02)			(-0.6)	
11:30-12:00	40.42%	45.89%	5.47%	46.87%	6.44%		42.45%	2.03%	
			(0.03)		(1.08)			(0.24)	
12:00-12:30	40.40%	43.53%	3.13%	37.88%	-2.52%		49.77%	9.37%	
			(0.01)		(-0.67)			(1.69)	
12:30-13:00	40.05%	44.98%	4.94%	43.30%	3.26%		44.70%	4.66%	
			(0.03)		(0.52)			(0.65)	
13:00-13:30	41.19%	38.99%	-2.20%	41.31%	0.12%		40.04%	-1.16%	
			(-0.05)		(-0.35)			(-0.35)	
13:30-14:00	42.60%	41.83%	-0.77%	41.19%	-1.41%		50.44%	7.84%	*
			(-0.03)		(-0.66)			(1.85)	
14:00-14:30	40.87%	46.71%	5.84%	38.81%	-2.06%		48.47%	7.60%	
			(0.03)		(-0.75)			(1.22)	

14:30-15:00	40.71%	45.83%	5.12%		29.91%	-10.80% ***		38.66%	-2.04%
			(0.02)			(-3.99)			(-0.05)
15:00-15:30	37.16%	39.71%	2.56%		34.45%	-2.71%		38.83%	1.67%
			(0.01)			(-0.92)			(0.01)
15:30-16:00	30.18%	33.19%	3.02%		31.52%	1.35%		31.74%	1.56%
			(0.02)			(0.10)			(-0.2)

CONCLUSION

As more research is conducted on off-exchange trading, we will learn more about this opaque market. It appears that traders tend to use off-exchange trading venues when they can acquire information before the event. Information acquisition is a costly process, and routing orders off-exchange gives traders better pricing to recuperate the costs and potentially profit from the transactions. However, traders are not willing to bear this execution risk when it comes to events that are non-reoccurring, and the timing of the announcement is unknown like with share repurchases. In fact, routing preference does not change around unscheduled events. These findings suggest that these traders are rational, and they take on risk, in this case, execution risk, when the opportunity to find information is available. Even under unprecedented, unpredictable times, their rational behavior persists evident by their unchanging trade routing preference.

REFERENCES

[1] Albulescu, C. T. (2021). COVID-19 and the United States financial markets' volatility. *Finance Research Letters*, 38, 101699. https://doi.org/10.1016/j.frl.2020.101699

[2] Ali, A., Klasa, S., & Zhen Li, O. (2008). Institutional stakeholdings and better-informed traders at earnings announcements. *Journal of Accounting and Economics*, 46(1), 47-61. https://doi.org/10.1016/j.jacceco.2008.06.001

[3] Amihud, Y., & Mendelson, H. (1991). Volatility, Efficiency, and Trading: Evidence from the Japanese Stock Market. *The Journal of Finance*, 46(5), 1765. https://doi.org/10.2307/2328572

[4] Baker, S.R., Bloom, N., Davis, S.J. and Terry, S.J., (2020). Covid-induced economic uncertainty (No. w26983). National Bureau of Economic Research.

[5] Bargeron, L., Kulchania, M., & Thomas, S. (2011). Accelerated share repurchases. *Journal of Financial Economics*, 101(1), 69-89. https://doi.org/10.1016/j.jfineco.2011.02.004

[6] Baruch, S., Panayides, M., & Venkataraman, K. (2017). Informed trading and price discovery before corporate events. *Journal of Financial Economics*, 125(3), 561-588. https://doi.org/10.1016/j.jfineco.2017.05.008

[7] Bhattacharya, U., & E. Jacobsen, S. (2016). The share repurchase announcement puzzle: Theory and evidence. *Review of Finance*, 20(2), 725-758.

[8] Bloomfield, R., O'Hara, M., & Saar, G. (2005). The "make or take" decision in an electronic market: Evidence on the evolution of liquidity. *Journal of Financial Economics*, 75(1), 165-199. https://doi.org/10.1016/j.jfineco.2004.07.001

[9] Boehmer, E., & Kelley, E. K. (2009). Institutional Investors and the Informational Efficiency of Prices. *Review of Financial Studies*, 22(9), 3563-3594. https://doi.org/10.1093/rfs/hhp028

[9] Buti, S., Rindi, B., & Werner, I. M. (2017). Dark pool trading strategies, market quality and welfare. *Journal of Financial Economics*, 124(2), 244-265. https://doi.org/10.1016/j.jfineco.2016.02.002

[10] Campbell, J. Y., Ramadorai, T., & Schwartz, A. (2009). Caught on tape: Institutional trading, stock returns, and earnings announcements. *Journal of Financial Economics*, 92(1), 66-91. https://doi.org/10.1016/j.jfineco.2008.03.006

[11] Chae, J. (2005). Trading volume, information asymmetry, and timing information. *Journal of Finance*, 60(1), 413-442. https://doi.org/10.1111/j.1540-6261.2005.00734.x

[12] Chen, H.-L., Jegadeesh, N., & Wermers, R. (2000). The value of active mutual fund management: An examination of the stockholdings and trades of fund managers. *Journal of Financial and Quantitative Analysis*, 343-368.

[13] Choi, J. H., Larsen, K., & Seppi, D. J. (2019). Information and trading targets in a dynamic market equilibrium. *Journal of Financial Economics*, 132(3), 22-49. https://doi.org/10.1016/j.jfineco.2018.11.003

[14] Crego, J. (2020) Why does public news augment information asymmetries? *Journal of Financial Economics*, 137, 72-89. https://doi.org/10.1016/j.jfineco.2019.05.020

[15] Daniel, K., Grinblatt, M., Titman, S., & Wermers, R. (1997). Measuring mutual fund performance with characteristic-based benchmarks. *The Journal of Finance*, 52(3), 1035-1058.

[16] Foley, S., & Putniņš, T. J. (2016). Should we be afraid of the dark? Dark trading and market quality. *Journal of Financial Economics*, 122(3), 456-481.

[17] Garvey, R., Huang, T., & Wu, F. (2016). Why do traders choose dark markets? *Journal of Banking & Finance*, 68, 12-28. https://doi.org/10.1016/j.jbankfin.2016.02.011

[18] Goldstein, M. A., & Kavajecz, K. A. (2004). Trading strategies during circuit breakers and extreme market movements. *Journal of Financial Markets*, 7(3), 301-333. https://doi.org/10.1016/j.finmar.2003.11.003

[19] Grinblatt, M., & Titman, S. (1993). Performance measurement without benchmarks: An examination of mutual fund returns. *Journal of Business*, 47-68.

[21] Haroon, O., & Rizvi, S. A. R. (2020). Flatten the Curve and Stock Market Liquidity – An Inquiry into Emerging Economies. *Emerging Markets Finance and Trad*e, 56(10), 2151-2161. https://doi.org/10.1080/1540496x.2020.1784716

[21] Ikenberry, D., Lakonishok, J., & Vermaelen, T. (1995). Market underreaction to open market share repurchases. *Journal of Financial Economics*, 39(2-3), 181-208. https://doi.org/10.1016/0304-405x(95)00826-z

[22] Kim, O., & Verrecchia, R.E. (1994). Market liquidity and volume around earnings announcements. *Journal of Accounting and Economics*, 17 (1-2), 41–67. http://dx.doi.org/10.1016/0165-4101(94)90004-3

[23] Kracher, B., & Johnson, R. R. (1997). Repurchase announcements, lies and false signals. *Journal of Business Ethics*, *16*(15), 1677-1685. https://www.jstor.org/stable/25073036

[24] Malmendier, U., & Nagel, S. (2011). Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?. *The Quarterly Journal of Economics*, 126(1), 373-416. https://doi.org/10.1093/qje/qjq004

[25] Menkveld, A. J., Yueshen, B. Z., & Zhu, H. (2017). Shades of darkness: A pecking order of trading venues. *Journal of Financial Economics*, 124(3), 503-534. https://doi.org/10.1016/j.jfineco.2017.03.004

[26] Ofer, A. R., & Thakor, A. V. (1987). A theory of stock price responses to alternative corporate cash disbursement methods: Stock repurchases and dividends. *The Journal of Finance*, 42(2), 365-394.

[27] Peyer, U., & Vermaelen, T. (2009). The Nature and Persistence of Buyback Anomalies. *Review of Financial Studies*, 22(4), 1693-1745. https://doi.org/10.1093/rfs/hhn024

[28] Rubin, A. (2007). Ownership level, ownership concentration and liquidity. *Journal of Financial Markets*, 10(3), 219-248. https://doi.org/10.1016/j.finmar.2007.04.002

[29] Schwartz, R.A. and Shapiro, J.E., (1992). The challenge of institutionalization for the equity markets. Salomon Bros. Center for the Study of Financial Institutions, Leonard N. Stern School of Business, New York University.

[30] Thaler, R. H., & Johnson, E. J. (1990). Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice. *Management Science*, 36(6), 643-660. https://doi.org/10.1287/mnsc.36.6.643

[31] Wermers, R. (1999). Mutual fund herding and the impact on stock prices. *The Journal of Finance*, 54(2), 581-622.

[32] Wermers, R. (2000). Mutual fund performance: An empirical decomposition into stock-picking talent, style, transactions costs, and expenses. *The Journal of Finance*, 55(4), 1655-1695.

[33] Ye, L. (2016). Understanding the impacts of dark pools on price discovery. Available at SSRN 2874957.

[34] Zhu, H. (2014). Do Dark Pools Harm Price Discovery? *Review of Financial Studies*, 27(3), 747-789. https://doi.org/10.1093/rfs/hht078

Appendix I. Variable Definition and Data Sources

| Variable	Definition	Source
OffVolshare	The proportion of off-exchange trading volume share at the given time interval	DTAQ
EventD	Dummy variable =1 if there is a firm event announcement at day t	IBES / Thomson Reuters SDC
IO	Number of shares held by institutions divided by the number of shares outstanding	SEC Form 13-F
IO_High	Dummy variable =1 if the firm has a high level of institutional ownership	
Ln(Size)	Natural logarithm of firm market capitalization	COMPUSTAT
Ln(Analyst Coverage)	Natural logarithm of the number of analysts	IBES
Analyst Forecast Dispersion	The standard deviation in the nearest earnings per share forecasts	IBES
Spread	Firm's quoted spread at the previous trading day	CRSP
Volatility	The difference between the daily high and low price divided by the closing midpoint	CRSP
InvP	The inverse of the share price	CRSP / DTAQ
Turnover	The number of shares traded divided by the number of shares outstanding	DTAQ, COMPUSTAT
VIX	Cboe Volatility Index	CBOE

Appendix II. Confirmation of Higher Information Asymmetry around Scheduled Events using Amihud Illiquidity Measure and the Cumulative Abnormal Log(Turnover)

Appendix II shows the information asymmetry around the earnings and repurchases announcement. The information asymmetry is proxied by the Amihud illiquidity measure and cumulative abnormal log(Turnover). Panel A reports the average daily Amihud illiquidity measures. The solid line represents the Amihud illiquidity measures around earnings announcement, and the dash line shows the Amihud illiquidity around repurchase announcement. Panel B plots the average cumulative abnormal log(turnover) around earnings and repurchase announcements.The definition and calculation of cumulative abnormal log(turnover) are following Chae (2005). The sample includes 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019.

Panel A: Amihud Illiquidity Measure
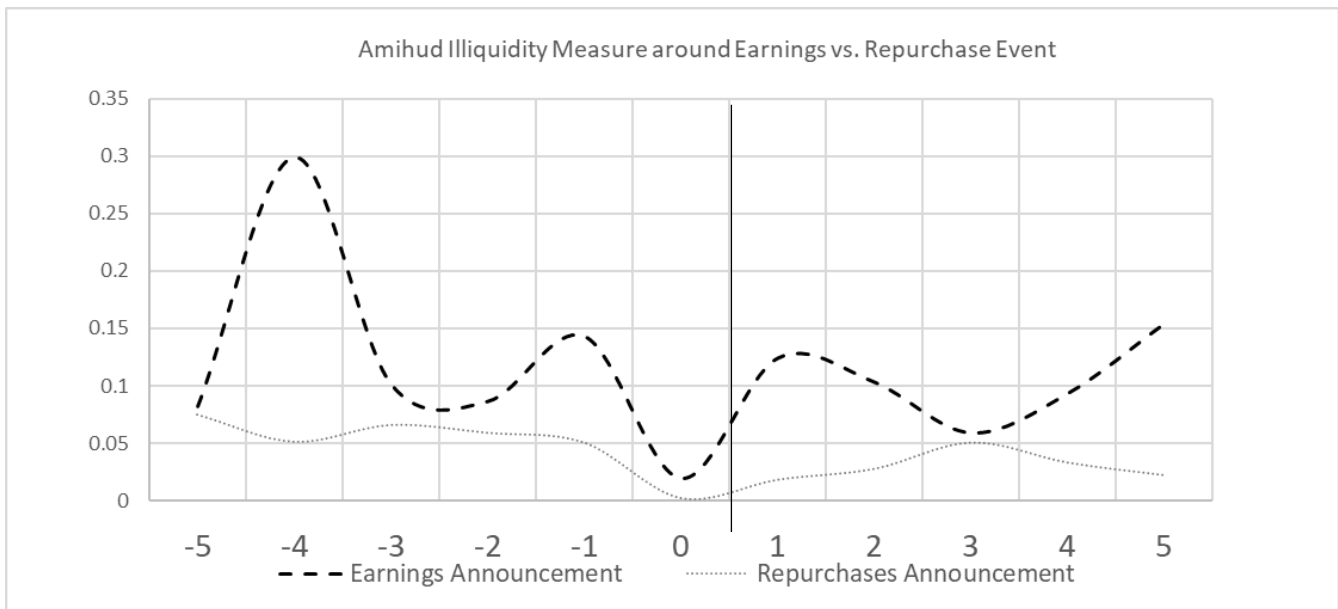
Panel B: Cumulative Abnormal Log(Turnover)
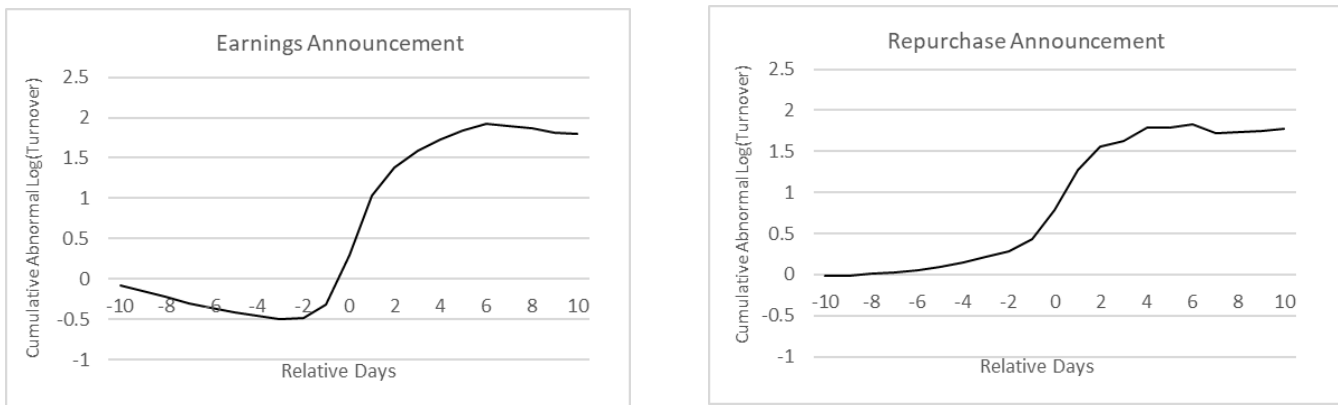
Appendix III. Differences in Off-exchange Trading Volume Share at Day Before the Earnings and Repurchase Announcements

This table presents the paired t-test results for the differences in the proportion of off-exchange trading volume share for the day before the earnings and repurchase announcements with the steady state in half-hour intervals. The sample includes off-market trading volumeshare for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The steady-state is calculated as the average proportion of the off-exchange trading volume share with no earnings and repurchase announcements. *Diff1* is the difference of off-exchange trading volume share between the day with earnings announcement and the steady-state; *Diff2* is the difference of off-exchange trading volume share between the day with repurchase announcement and the steady-state. Paired t-tests are used to calculate the differences, and the t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Time	Steady State	Earnings Announcement Off-exchange Trading	Diff 1		Share Repurchase Announcement Off-exchange Trading	Diff 2	
9:30-10:00	27.08%	29.08%	2.00%	***	27.72%	0.65%	
			(11.12)			(0.94)	
10:00-10:30	33.35%	34.32%	0.97%	***	33.28%	-0.06%	
			(4.15)			(0.12)	
10:30-11:00	33.33%	34.28%	0.95%	***	33.06%	-0.27%	
			(4.21)			(-0.15)	
11:00-11:30	33.78%	34.82%	1.04%	***	33.43%	-0.35%	
			(5.26)			(-0.36)	
11:30-12:00	33.38%	34.36%	0.98%	***	32.48%	-0.90%	
			(4.97)			(-1.03)	
12:00-12:30	32.97%	34.15%	1.18%	***	30.33%	-2.64%	***
			(4.76)			(-3.16)	
12:30-13:00	32.88%	33.62%	0.74%	***	32.50%	-0.38%	
			(3.88)			(-0.51)	
13:00-13:30	32.47%	33.71%	1.25%	***	32.32%	-0.15%	
			(5.95)			(-0.19)	
13:30-14:00	33.22%	33.78%	0.56%	***	31.75%	-1.47%	

Time	Steady State	Earnings Announcement Off-Exchange Trading	Diff 1		Share Repurchase Announcement Off-Exchange Trading	Diff 2
			(2.73)			*(-1.55)*
14:00-14:30	32.97%	33.90%	0.93%	***	32.21%	-0.76%
			(4.18)			*(-0.75)*
14:30-15:00	32.46%	33.63%	1.17%	***	33.89%	1.43%
			(5.17)			*(1.87)*
15:00-15:30	31.50%	32.77%	1.27%	***	31.09%	-0.41%
			(5.83)			*(-0.15)*
15:30-16:00	26.19%	28.26%	2.07%	***	26.17%	-0.02%
			(11.38)			*(0.49)*

Appendix IV. Differences in Off-exchange Trading Volume Share at Day After the Earnings and Repurchase Announcements

This table presents the paired t-test results for the differences in the proportion of off-exchange trading volume share for the day after the earnings and repurchase announcements with the steady-state in half-hour intervals. The sample includes off-exchange trading volumeshare for 1,002 firms that have both earnings and repurchase announcements between January 2014 and December 2019. The steady-state is calculated as the average proportion of the off-exchange trading volume share with no earnings and repurchase announcements. *Diff1* is the difference of off-exchange trading volume share between the day with earnings announcement and the steady-state; *Diff2* is the difference of off-exchange trading volume share between the day with repurchase announcement and the steady-state. Paired t-tests are used to calculate the differences, and the t-statistics are reported in parentheses. Statistical significance at the 5%, 1%, and 0.1% levels is denoted by *, **, and ***, respectively.

Panel A: Difference in half-hour interval

Time	Steady State	Earnings Announcement Off-Exchange Trading	Diff 1		Share Repurchase Announcement Off-Exchange Trading	Diff 2
9:30-10:00	27.08%	33.10%	6.03%	***	27.96%	0.89%
			(29.04)			*(1.31)*
10:00-10:30	33.35%	37.96%	4.62%	***	33.98%	0.63%
			(21.61)			*(0.71)*
10:30-11:00	33.33%	37.26%	3.93%	***	34.31%	0.98%
			(19.27)			*(1.16)*
11:00-11:30	33.78%	37.67%	3.90%	***	34.52%	0.74%

						(17.84)	*(0.81)*
11:30-12:00	33.38%	37.32%	3.94%	***	33.66%	0.27%	
			(18.42)			*(0.27)*	
12:00-12:30	32.97%	36.62%	3.65%	***	34.85%	1.88%	*
			(15.24)			*(1.97)*	
12:30-13:00	32.88%	36.28%	3.40%	***	32.67%	-0.21%	
			(16.31)			*(-0.22)*	
13:00-13:30	32.47%	36.47%	4.00%	***	32.39%	-0.08%	
			(18.76)			*(-0.14)*	
13:30-14:00	33.22%	36.28%	3.06%	***	34.21%	0.99%	
			(14.07)			*(1.26)*	
14:00-14:30	32.97%	35.85%	2.88%	***	33.22%	0.25%	
			(14.06)			*(0.4)*	
14:30-15:00	32.46%	36.11%	3.66%	***	32.75%	0.29%	
			(17.8)			*(0.56)*	
15:00-15:30	31.50%	34.79%	3.29%	***	30.19%	-1.31%	
			(17.23)			*(-1.65)*	
15:30-16:00	26.19%	30.30%	4.11%	***	26.94%	0.75%	
			(24.42)			*(1.55)*	