# Examining Intraday ETF Liquidity: *When Should Investors Trade?*

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## WHY ARE BID/ASK SPREADS IMPORTANT?

Exchange-traded funds (ETFs) are commonly used investment vehicles that blend the investment benefits and characteristics of traditional mutual funds with the trading flexibility of individual securities.[1] Although this flexibility is part of what makes ETFs so appealing, it exposes investors to the nuances of transacting in fund shares on stock exchanges. In addition, the liquidity added by the capability to purchase or sell shares at any point during the trading day is not without cost. ETF investors are subject to costs similar to those incurred when trading individual securities.

An ETF's intraday trading costs include the fund's bid/ask spread at the time of the transaction, any market impact that moves the spread beyond the target price, and fees charged by a broker to transact less any price improvement the broker provides.[2] Although investors should be mindful of the total costs of an ETF over time, including the expense ratio, the bid/ask spread is an important measure of the one-time cost incurred when transacting. The wider the spread, the more it costs to transact in an ETF, effectively reducing the net investment (or proceeds) when buying (or selling). Because an ETF's spread can vary from less than one basis point to a few hundred basis points, investors must trade intelligently to avoid wider-than-average spreads when possible.

Most practitioners regard the trading volume of an ETF's shares and the liquidity of its underlying holdings as the main drivers of spreads. A significant amount of research indicates that high trading volume correlates with tighter spreads (Agrrawal and Clark, 2009). Relatively higher trading volume indicates a larger community of buyers and sellers, which creates greater price discovery, increases price competition to complete a transaction, and reduces spreads.

An ETF's spread can also be affected by the liquidity of the fund's underlying securities. The ETF's creation and redemption mechanism creates an arbitrage band set by the transaction costs of the underlying portfolio (Vanguard Asset Management, 2015). For US equities, the correlation between market capitalization and trading volume results in large-capitalization stocks generally having tighter bid/ask spreads than small-cap stocks.

[1] For additional commentary on the use of ETFs versus traditional mutual funds, see Dickson, Kwon, and Rowley Jr. (2015).

[2] An ETF's bid/ask spread is the difference between the highest price at which market participants are willing to buy that security (bid) and the lowest price at which they are willing to sell it (ask). Price improvement refers to the practice of a broker executing a client trade at a price inside the quoted bid/ask spread, usually driven by crossing transactions from different clients.



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ETFs that track a particular market-capitalization segment of the equity market tend to reflect the liquidity costs of that segment.

In addition to these fund-specific factors, industry conventional wisdom advises investors to avoid trading near market open and market close, when spreads may be wider.[3] Our research attempts to quantify the effect of time of day on bid/ask spreads during the average trading day for US-listed domestic equity ETFs. Our analysis includes controls for known spread drivers such as volume and general characteristics of underlying portfolios. We also add controls for the ETF issuer, based on several assumptions. First, investors with different trading behaviors may have a preference for certain ETFs. Second, an issuer's full lineup might have characteristics not captured by our controls, such as investments in an efficient creation and redemption mechanism. Third, issuers may have different approaches to engagement in the ETF liquidity provider community, influencing how their funds trade.

In the rest of this paper, we describe our data sample and methodology, review the summary results of our analysis, show the results of our multivariate regressions, offer some additional considerations, and present our conclusions.

## EXAMINING SPREADS THROUGHOUT THE TRADING DAY

Our analysis was inspired by the methodology established by Ozenbas, Pagano, and Schwartz (2010). For that study, the authors divided the trading day into 30-minute windows to examine the effect of time of day on stock price volatility. For our research, we divided the trading day into 5-minute periods (78 total). After testing numerous intervals, we concluded that this method captured the data sufficiently finely to reveal subtle market trends.[4]

From OneMarketData LLC, we collected millisecond-by-millisecond trade price, volume, and National Best Bid and Offer (NBBO) quote data for available US-domiciled domestic equity ETFs (as defined by Morningstar Direct) for 247 full trading days during 2017.[5] We calculated each fund's average bid/ask spread in basis points (based on NBBO) during each time window.[6] Although each interval contained an average spread for every fund, not all observations had complete volume data. Therefore, our analysis omitted any observations that did not contain volume data.[7]

Our dataset did not include the opening and closing auctions, when stock exchanges match orders entered before the auctions, because the matching process differs from that of transacting during the trading day. We used Morningstar Direct to identify each fund's issuer and market capitalization category (large-, mid-, or small-cap—our proxy for the liquidity of a fund's underlying securities). Exhibit 1 displays a summary of our data.[8]

Exhibit 2 shows the mean and median average ETF bid/ask spread during each 5-minute interval throughout the trading day. Spreads are especially wide immediately following market open and then appear to level off. Furthermore, counter to the more qualitative guidance that many ETF issuers have historically provided, spreads actually appear to *tighten* near the end of the day. Therefore, investors who typically transact at NBBO in domestic equity ETFs may want to avoid the market open to reduce transaction costs but perhaps need not worry about placing orders in the afternoon.

[3] For industry examples that argue against trading at market open and close, see Pollack (2017), Anderson (2017), Direxion (2018), Fidelity (2018), Charles Schwab (2014), BlackRock (2018), Hammond and Lieder (2015), and Dickson and Rowley Jr. (2014).

[4] A time window is an aggregation of all data points observed between exactly the start of the interval and the last millisecond before the start of the next interval. For example, the 9:30–9:35 a.m. interval runs from 9:30 a.m. until the last millisecond of 9:34 a.m.

[5] We chose to include only US-domiciled domestic equity funds to eliminate complications associated with other asset classes, namely the differing market hours and pricing uncertainty of international equity and bond markets. Because of the sheer number of observations in an intraday dataset, our analysis focused exclusively on 2017. We chose to exclude the 3 days with early market close in 2017 to better represent spreads during the average trading day. We also excluded leveraged ETFs because their market behavior differs from that of general domestic equity funds.

[6] To calculate average spread in basis points, we took the bid value and ask value of every NBBO quote posted during each time window and calculated as follows: {(ask price − bid price)/[(ask price + bid price)/2]} × 10,000. We then calculated the average of all spread observations that occurred in each time window.

[7] The proportion of omitted observations was fairly evenly distributed across all time intervals, with a median omission of 4 percent. No interval omitted more than 5 percent of all observations.

[8] We converted average spread and volume to natural logarithm form to linearize the data.



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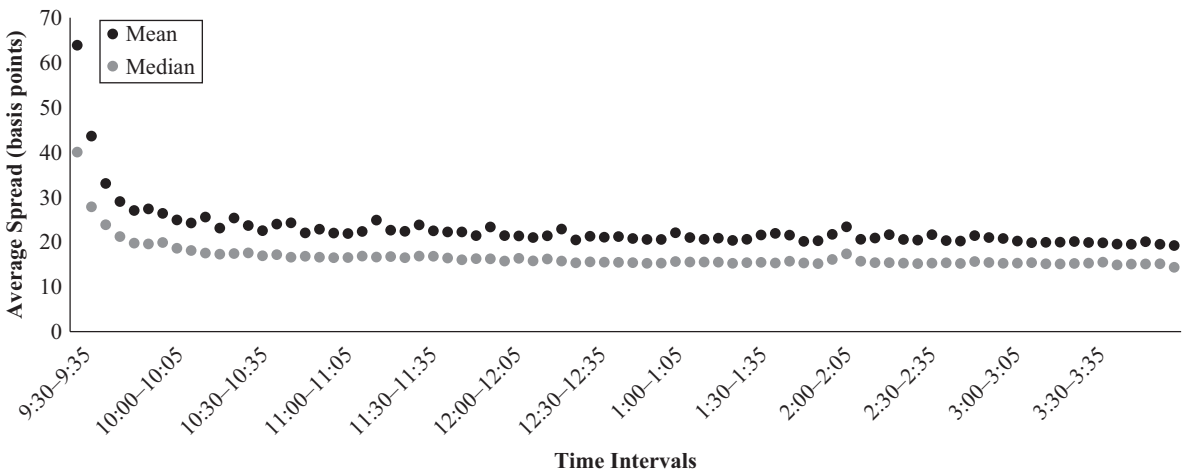
## EXHIBIT 1
**Summary of Data**

| Variables | Mean | Standard Error | Standard Deviation | Number of Observations | First Quartile | Third Quartile |
|---|---|---|---|---|---|---|
| Bid/Ask Spread | 22.89 | 0.14 | 33.54 | 55,781 | 6.32 | 27.57 |
| (*Natural log*) | *2.61* | *0.00* | *1.06* | | *1.84* | *3.32* |
| Notional Volume | $17,163,660 | $492,954 | $11,875,118 | 55,781 | $81,932 | $2,948,632 |
| (*Natural log*) | *13.15* | *0.01* | *2.75* | | *11.31* | *14.90* |
| Large-Cap Spread | 18.28 | 0.16 | 27.48 | 30,127 | 4.66 | 23.08 |
| (*Natural log*) | *2.38* | *0.01* | *1.06* | | *1.54* | *3.14* |
| Mid-Cap Spread | 26.47 | 0.28 | 37.58 | 17,728 | 8.53 | 37.58 |
| (*Natural log*) | *2.81* | *0.01* | *0.99* | | *2.14* | *3.43* |
| Small-Cap Spread | 32.33 | 0.46 | 41.13 | 7,926 | 13.01 | 37.90 |
| (*Natural log*) | *3.05* | *0.01* | *0.96* | | *2.57* | *3.63* |

*Note: When the mean, standard error, standard deviation, and first- and third-quartile spread figures are not in natural log scale, they are shown in basis points.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*

## EXHIBIT 2
**Typical ETF Spread: Wider in the Morning and Tighter in the Afternoon**




*Notes: This exhibit displays the mean and median average bid/ask spread for all time intervals. An ETF's average bid/ask spread is the mean of its spreads in each of the 5-minute intervals (78 total) for all trading days in our 2017 sample.*

*Source: Authors' calculations, using data from OneMarketData LLC.*

Our finding that spreads appear to be widest in the early hours of the trading day supports the general consensus that market participants collectively set ETF spreads relatively wider in the morning. This circumstance allows for price discovery in a fund's underlying securities stemming from overnight news (Oztekin, et al. 2017). After market open, spreads do not appear to tighten to near an intraday average value until after 10:00 a.m. This result suggests that investors should refrain from trading for a bit longer than previously believed to allow for completion of the price discovery process.

Exhibit 3 suggests that the liquidity of a fund's underlying securities is an important driver of spreads.



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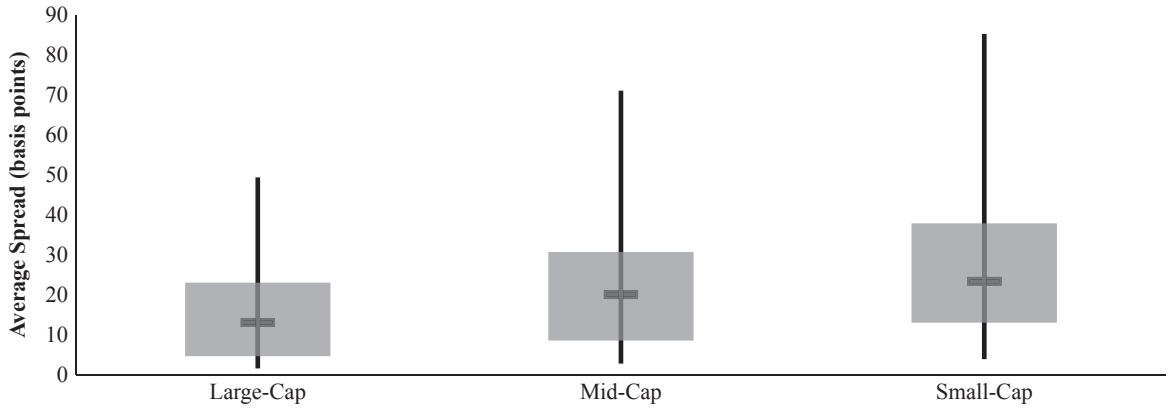
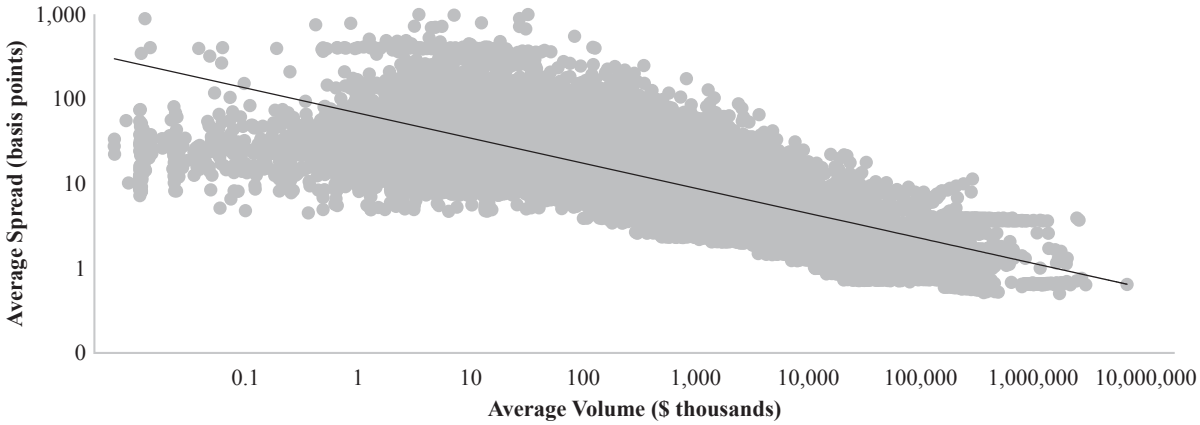
## EXHIBIT 3
**Tighter Spreads with More Liquid Portfolios**




*Notes: This exhibit displays the distribution of average bid/ask spreads for each fund category as represented by the mean of each ETF's bid/ask spread in each of the 5-minute intervals (78 total) for all trading days in our 2017 sample. The boxes include the 75th to 25th percentile values; the whiskers extend to the 95th and 5th percentile values; and the dashes represent the median value.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*

## EXHIBIT 4
**Falling Spreads as Trading Volume Increases**




*Notes: This exhibit displays the relationship between ETFs' average bid/ask spread and average trading volume, as represented by their respective means in each of the 5-minute intervals (78 total) for all trading days in our 2017 sample. Spread and volume are shown in logarithmic scale.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*

We used Morningstar fund category as a proxy variable for this liquidity.[9]

As expected, we found that ETFs that invest primarily in large-cap securities averaged tighter spreads over our sample period. As the market capitalization of the underlying securities decreased, the mean and variance of average spreads increased.

In addition, our results show that a fund's average spread is strongly correlated with trading volume, a relationship generally accepted by the ETF industry (ETF.com, 2018). As shown in Exhibit 4, the spreads fall as

[9] Our analysis relies on the assumption that, all else equal, large-cap securities are more liquid than mid-caps, which are, in turn, more liquid than small-caps.



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trading volume increases. The *R*-squared for a univariate regression of log of average spread on log of volume is 59.1 percent.

## WHAT DRIVES ETF SPREADS?

To test the statistical robustness of our findings, we conducted a series of linear regressions. We structured each regression as a pooled panel least-squares linear model. First, we regressed average natural log of spread on time interval. Next, we conducted three stepwise regressions that controlled for fund category, (natural log of) volume, and issuer. We defined our ultimate multivariate model as follows:

$$\begin{aligned} &Log\ Avg.\ Spread_{i,t} \\ &\quad = \alpha + \beta_1 Time\ Interval_t + \beta_2 Fund\ Category_i \\ &\qquad + \beta_3 Log\ Volume_{i,t} + \beta_4 Issuer_i + \varepsilon_{i,t}\ ^{10} \end{aligned}$$

where

*Log Avg. Spread*$_{i,t}$ *is the natural* log *of average spread for a fund* "*i*" at each time interval "*t*".

*Time interval*$_t$ *is a* 1/0 *variable indicating in which of the time intervals the observation falls.*

*Fund Category*$_i$ *is a* 1/0 *variable indicating whether the fund is large-, mid-, or small-cap.*

*Log Volume*$_{i,t}$ *is the natural* log *of average volume for a fund* "*i*" at each time interval "*t*".

*Issuer*$_i$ *is a* 1/0 *variable indicating the fund's issuer.*

Exhibit 5 displays the results of this model.

Panel A displays the results of regressing average bid/ask spread only on time interval. Our findings indicate that, all else equal, average spreads are significantly wider during the first 50 minutes of the trading day than during the control period. The first seven intervals (35 total minutes) are significant to 0.1 percent; the next three (15 total minutes) are significant to at least 5 percent. Near market close, the spreads tighten: Four of the final five intervals are significant to at least 5 percent.

Panel B displays the results after incorporating fund category, the proxy variable for an ETF's underlying liquidity. As expected, the mid-cap and small-cap fund variables have positive coefficients and are highly significant; they have wider spreads than large-cap funds. The time interval coefficients remain substantially similar to those in Panel A. The adjusted *R*-squared increases from 2.4 percent to 8.6 percent.

Panel C displays the results after adding average trading volume. Higher volume is associated with tighter spreads and is highly significant. Trading volume is also a powerful explanatory variable; the introduction of volume causes the adjusted *R*-squared to jump more than 50 percentage points. The fund category coefficients remain substantially similar, suggesting that investors should pay attention to an ETF's underlying asset class even for heavily traded products.

After controlling for volume, our results indicate that the widest spreads of the trading day still occur in the first 40 minutes. Among the final five time intervals, only the coefficient for the last one is statistically distinguishable from zero; it flips to a positive significance of 0.1 percent. This outcome suggests that increased trading volume during the last 25 minutes of the trading day causes the tightening spreads observed in the first two panels. Exhibit 6 illustrates these trends.

Panel D shows the results after introducing an ETF issuer fixed-effect variable to control for subtle differences among issuers that may affect average spreads. (For more detail on the distribution of bid/ask spreads across issuers, see Appendix A.) For example, certain investors may have an affinity (for reasons such as product investment exposure, product structure, and/or sales and marketing efforts) for ETFs from a particular issuer, leading to liquidity profiles that differ systematically among issuers. In addition, issuers differ in their approach to engagement with market participants through capital markets teams, potentially leading to different liquidity outcomes. The introduction of the issuer variable raises the *R*-squared value of the regression to 74 percent. However, the coefficients for the key time intervals, fund category, and volume are substantially similar to those for Panel C.[11]

Our multivariate regression analysis confirms our initial finding that average spreads of domestic equity ETFs are wider in the morning, likely the result of price discovery occurring in the underlying equities market.

[10] We chose 12:00–12:05 p.m. as the control for time intervals and selected large-cap for category. We chose Ark Investment Management as the control for issuers because it had the median average issuer bid/ask spread.

[11] We also conducted a regression using individual fund fixed effects rather than issuer fixed effects. The results related to time interval were substantially similar.



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## EXHIBIT 5

**Many Factors That Influence ETF Spreads throughout the Trading Day**

| Independent Variables | Panel A | Panel B | Panel C | Panel D |
|---|---|---|---|---|
| 9:30–9:35 | 1.06*** | 1.06*** | 1.18*** | 1.18*** |
| 9:35–9:40 | 0.60*** | 0.60*** | 0.66*** | 0.66*** |
| 9:40–9:45 | 0.41*** | 0.41*** | 0.46*** | 0.45*** |
| 9:45–9:50 | 0.30*** | 0.30*** | 0.33*** | 0.33*** |
| 9:50–9:55 | 0.23*** | 0.23*** | 0.27*** | 0.26*** |
| 9:55–10:00 | 0.24*** | 0.24*** | 0.27*** | 0.27*** |
| 10:00–10:05 | 0.22*** | 0.23*** | 0.26*** | 0.26*** |
| 10:05–10:10 | 0.15** | 0.15** | 0.20*** | 0.20*** |
| 10:10–10:15 | 0.12* | 0.13* | 0.15*** | 0.15*** |
| 10:15–10:20 | 0.11* | 0.12* | 0.15*** | 0.15*** |
| 10:20–10:25 | 0.08 | 0.08 | 0.11*** | 0.10*** |
| 10:25–10:30 | 0.12* | 0.12* | 0.16*** | 0.16*** |
| 10:30–10:35 | 0.10 | 0.10 | 0.13*** | 0.13*** |
| 10:35–10:40 | 0.05 | 0.05 | 0.07* | 0.06* |
| 10:40–10:45 | 0.06 | 0.06 | 0.09** | 0.09*** |
| 10:45–10:50 | 0.05 | 0.05 | 0.06 | 0.06* |
| 10:50–10:55 | 0.02 | 0.03 | 0.04 | 0.04 |
| 10:55–11:00 | 0.04 | 0.04 | 0.07* | 0.06* |
| 11:00–11:05 | 0.02 | 0.03 | 0.02 | 0.02 |
| 11:05–11:10 | 0.01 | 0.02 | 0.04 | 0.04 |
| 11:10–11:15 | 0.03 | 0.04 | 0.06* | 0.06* |
| 11:15–11:20 | 0.07 | 0.06 | 0.09** | 0.09*** |
| 11:20–11:25 | 0.04 | 0.04 | 0.05 | 0.06* |
| 11:25–11:30 | 0.04 | 0.04 | 0.06* | 0.06* |
| 11:30–11:35 | 0.05 | 0.05 | 0.08** | 0.08** |
| 11:35–11:40 | 0.04 | 0.05 | 0.06 | 0.05* |
| 11:40–11:45 | 0.02 | 0.02 | 0.03 | 0.03 |
| 11:45–11:50 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11:50–11:55 | 0.01 | 0.01 | 0.01 | 0.01 |
| 11:55–12:00 | 0.02 | 0.02 | 0.00 | 0.01 |
| 12:05–12:10 | –0.00 | –0.00 | –0.01 | –0.01 |
| 12:10–12:15 | –0.01 | –0.01 | –0.03 | –0.03 |
| 12:15–12:20 | –0.00 | –0.00 | –0.03 | –0.03 |
| 12:20–12:25 | –0.01 | –0.01 | –0.03 | –0.03 |
| 12:25–12:30 | –0.04 | –0.03 | –0.05 | –0.04 |
| 12:30–12:35 | –0.02 | –0.02 | –0.05 | –0.05 |
| 12:35–12:40 | –0.03 | –0.03 | –0.05 | –0.04 |
| 12:40–12:45 | –0.02 | –0.02 | –0.05 | –0.05 |
| 12:45–12:50 | –0.04 | –0.04 | –0.07* | –0.07** |
| 12:50–12:55 | –0.04 | –0.04 | –0.07* | –0.06* |
| 12:55–1:00 | –0.04 | –0.04 | –0.08** | –0.08** |

*(continued)*



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## EXHIBIT 5 *(continued)*

**Many Factors That Influence ETF Spreads throughout the Trading Day**

| Independent Variables | Panel A | Panel B | Panel C | Panel D |
|---|---|---|---|---|
| 1:00–1:05 | –0.01 | –0.01 | –0.05 | –0.04 |
| 1:05–1:10 | –0.03 | –0.03 | –0.07* | –0.07* |
| 1:10–1:15 | –0.04 | –0.04 | –0.07* | –0.06* |
| 1:15–1:20 | –0.04 | –0.04 | –0.08** | –0.09** |
| 1:20–1:25 | –0.05 | –0.05 | –0.11*** | –0.11*** |
| 1:25–1:30 | –0.04 | –0.04 | –0.07* | –0.07* |
| 1:30–1:35 | –0.04 | –0.04 | –0.06* | –0.05* |
| 1:35–1:40 | –0.05 | –0.04 | –0.08* | –0.07** |
| 1:40–1:45 | –0.03 | –0.03 | –0.04 | –0.04 |
| 1:45–1:50 | –0.06 | –0.06 | –0.06 | –0.06* |
| 1:50–1:55 | –0.05 | –0.05 | –0.06* | –0.06* |
| 1:55–2:00 | –0.00 | –0.00 | 0.00 | 0.00 |
| 2:00–2:05 | 0.08 | 0.08 | 0.09** | 0.10*** |
| 2:05–2:10 | –0.03 | –0.03 | –0.01 | –0.01 |
| 2:10–2:15 | –0.03 | –0.03 | 0.00 | –0.00 |
| 2:15–2:20 | –0.03 | –0.03 | –0.00 | –0.00 |
| 2:20–2:25 | –0.05 | –0.05 | –0.02 | –0.03 |
| 2:25–2:30 | –0.05 | –0.05 | –0.03 | –0.02 |
| 2:30–2:35 | –0.06 | –0.06 | –0.02 | –0.02 |
| 2:35–2:40 | –0.06 | –0.06 | –0.02 | –0.02 |
| 2:40–2:45 | –0.06 | –0.06 | –0.01 | –0.01 |
| 2:45–2:50 | –0.03 | –0.03 | 0.03 | 0.02 |
| 2:50–2:55 | –0.04 | –0.04 | 0.01 | 0.00 |
| 2:55–3:00 | –0.06 | –0.06 | –0.01 | –0.01 |
| 3:00–3:05 | –0.06 | –0.06 | –0.00 | –0.00 |
| 3:05–3:10 | –0.08 | –0.08 | –0.03 | –0.03 |
| 3:10–3:15 | –0.08 | –0.08 | –0.02 | –0.02 |
| 3:15–3:20 | –0.09 | –0.09 | 0.00 | 0.00 |
| 3:20–3:25 | –0.09 | –0.08 | 0.00 | –0.00 |
| 3:25–3:30 | –0.09 | –0.09 | 0.00 | –0.00 |
| 3:30–3:35 | –0.09 | –0.09 | 0.01 | 0.00 |
| 3:35–3:40 | –0.11* | –0.10* | 0.02 | 0.01 |
| 3:40–3:45 | –0.11* | –0.11* | 0.01 | 0.00 |
| 3:45–3:50 | –0.10 | –0.10 | 0.05 | 0.04 |
| 3:50–3:55 | –0.12* | –0.12* | 0.03 | 0.02 |
| 3:55–4:00 | –0.17** | –0.16** | 0.12*** | 0.11*** |
| Mid-cap | | 0.43*** | 0.39*** | 0.34*** |
| Small-cap | | 0.67*** | 0.55*** | 0.52*** |
| Volume (log) | | | –0.29*** | –0.27*** |
| Issuer fixed effect | No | No | No | Yes |
| Adjusted *R*-squared | 2.4% | 8.6% | 66.6% | 74.0% |

*Notes*: * *Significant to 5 percent.* ** *Significant to 1 percent.* *** *Significant to 0.1 percent.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*



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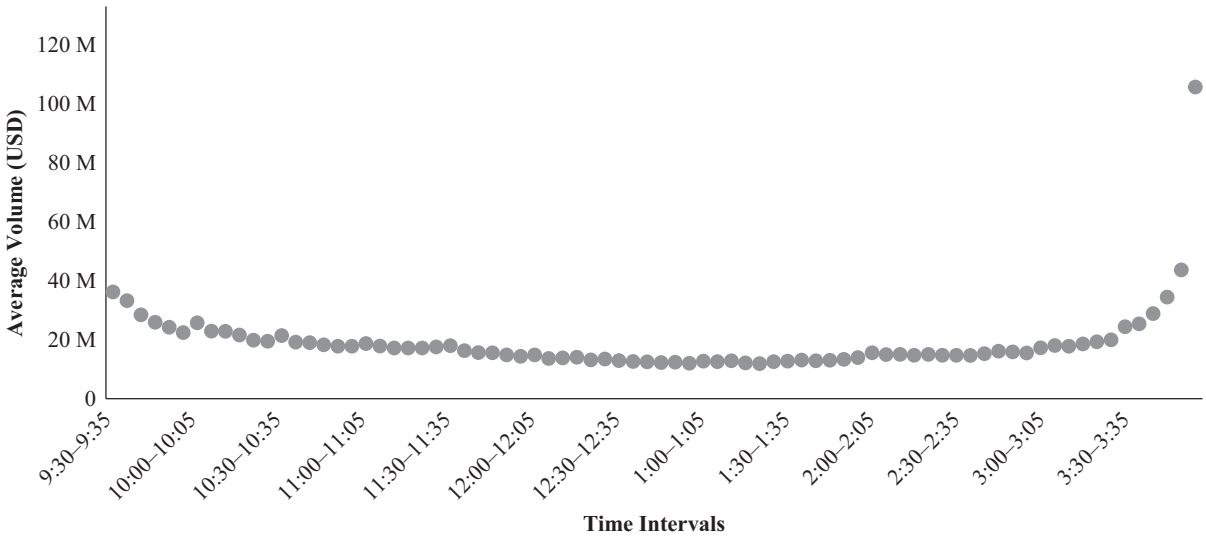
## EXHIBIT 6

**Higher Trading Volume Trends toward the End of the Day**




*Notes: This exhibit displays the mean average trading volume for all time intervals. An ETF's average trading volume is the mean of its trading volume in each of the 5-minute (78 total) time intervals for all trading days in our 2017 sample.*

*Source: Authors' calculations, using data from OneMarketData LLC.*

The result is statistically robust after controlling for fund category, trading volume, and issuer effects.

Average spreads appear tightest in the 25 minutes before market close; however, this effect is reversed after adding controls for fund category and volume. Average spreads then appear elevated during the final 5 minutes, perhaps reflecting some uncertainty or hedging activity toward the end of the trading session. However, because the final 25 minutes are marked by substantially increased volume, the overall effect is one of tighter bid/ask spreads. Therefore, our findings do not support the typical historical guidance that investors should avoid trading near the close of the trading day, at least when transacting at NBBO for domestic equity ETFs.

Exhibit 7 displays the resulting coefficient for each time interval from the Panel D regression, highlighting intervals significant to 0.1 percent. It shows a statistically significant widening of spreads at 2:00 p.m., when the Federal Open Market Committee (FOMC) makes announcements. This result suggests that market participants are pricing uncertainty into ETF spreads at this time. However, results from Panels A and B indicate that greater volume near the time of the announcement offsets that effect. For that reason, we advise investors to be vigilant when trading near the time when the FOMC is scheduled to make announcements, notably those related to interest rate changes. Although investors should be aware of general market conditions whenever transacting, this finding seems to highlight FOMC announcement time frames as specific recurring periods of potentially elevated spreads. During such times, investors should be mindful of the order type they are using and their overall approach to trading in order to minimize transaction costs.[12]

## ADDITIONAL CONSIDERATIONS

Because we analyze the NBBO spreads of US-equity ETFs, our conclusions are a useful reference for most investors. They may not apply to all investors in all ETFs; some of their trades may be affected by size and how they access the market. For example, some investors might be able to tap into off-exchange liquidity if the liquidity providers can access an ETF's

[12] For additional information on trade order types, see US Securities and Exchange Commission (2017).



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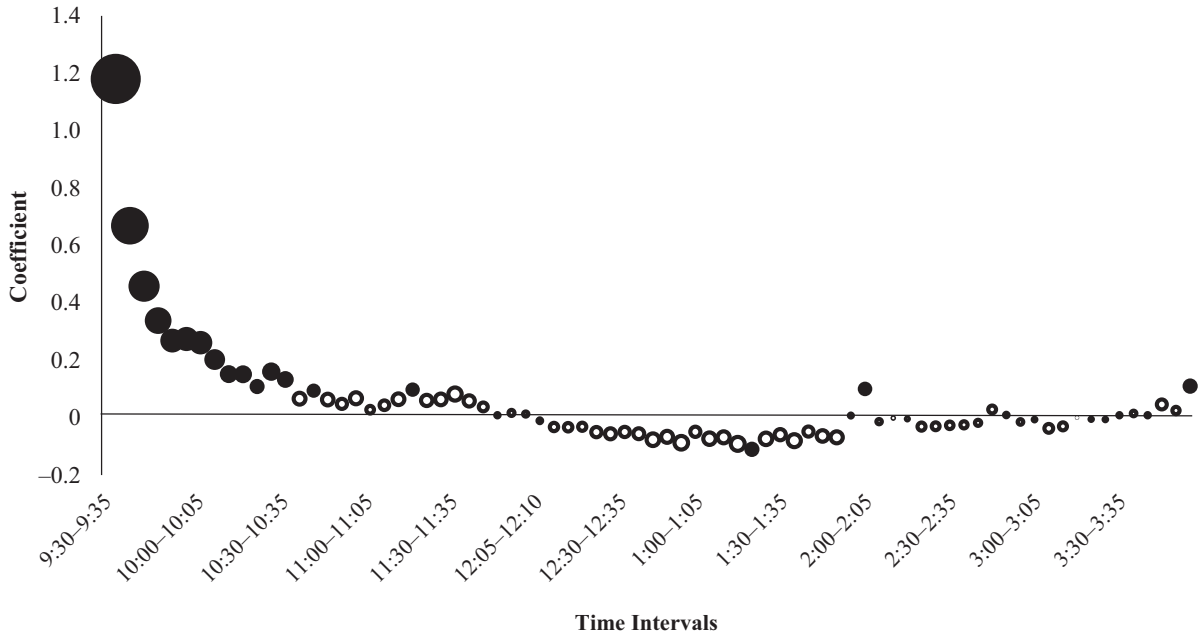
## EXHIBIT 7

**Time of Day as a Significant Driver of an ETF's Bid/Ask Spread**




*Notes: This exhibit shows the coefficient for each 5-minute period after (natural log of) average bid/ask spread was regressed on time interval, fund category, (natural log of) average trading volume, and issuer (results from Panel D).* T*-statistic determines both the shading and relative size of each bubble. Solid bubbles indicate significance to 0.1 percent. Relatively larger bubbles indicate relatively larger absolute* t*-statistic values.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*

primary market.[13] ETFs that track indexes of asset classes other than US equity, are listed outside the United States, or employ more complex investment strategies (such as leverage) may also have different trading characteristics.

Because NBBO serves as an estimate of an investor's likely transaction costs, this analysis reflects neither the market impact of actual realized trades larger than the size posted at NBBO nor the price improvement that a broker may offer. Moreover, while we focus on bid/ask spreads, we encourage investors to evaluate ETF investments in the context of their total cost of ownership.

[13] The primary market for ETF shares is a transaction between the ETF issuer and the authorized participant, which then transacts in the public secondary market on an exchange.

## CONCLUSION

Our analysis supports the argument that ETF investors should avoid trading near market open because of ongoing price discovery in the funds' underlying holdings. Our results do not support industry conventional wisdom that investors should avoid trading US domestic equity ETFs near the close of the trading day. To the contrary, we find that average bid/ask spreads continue to tighten at that point as a result of increasing trading volume. Unexpectedly, we also find that after controls, spreads are higher during the time of day when FOMC announcements take place, confirming the practitioner guidance of avoiding trading during periods of uncertainty.



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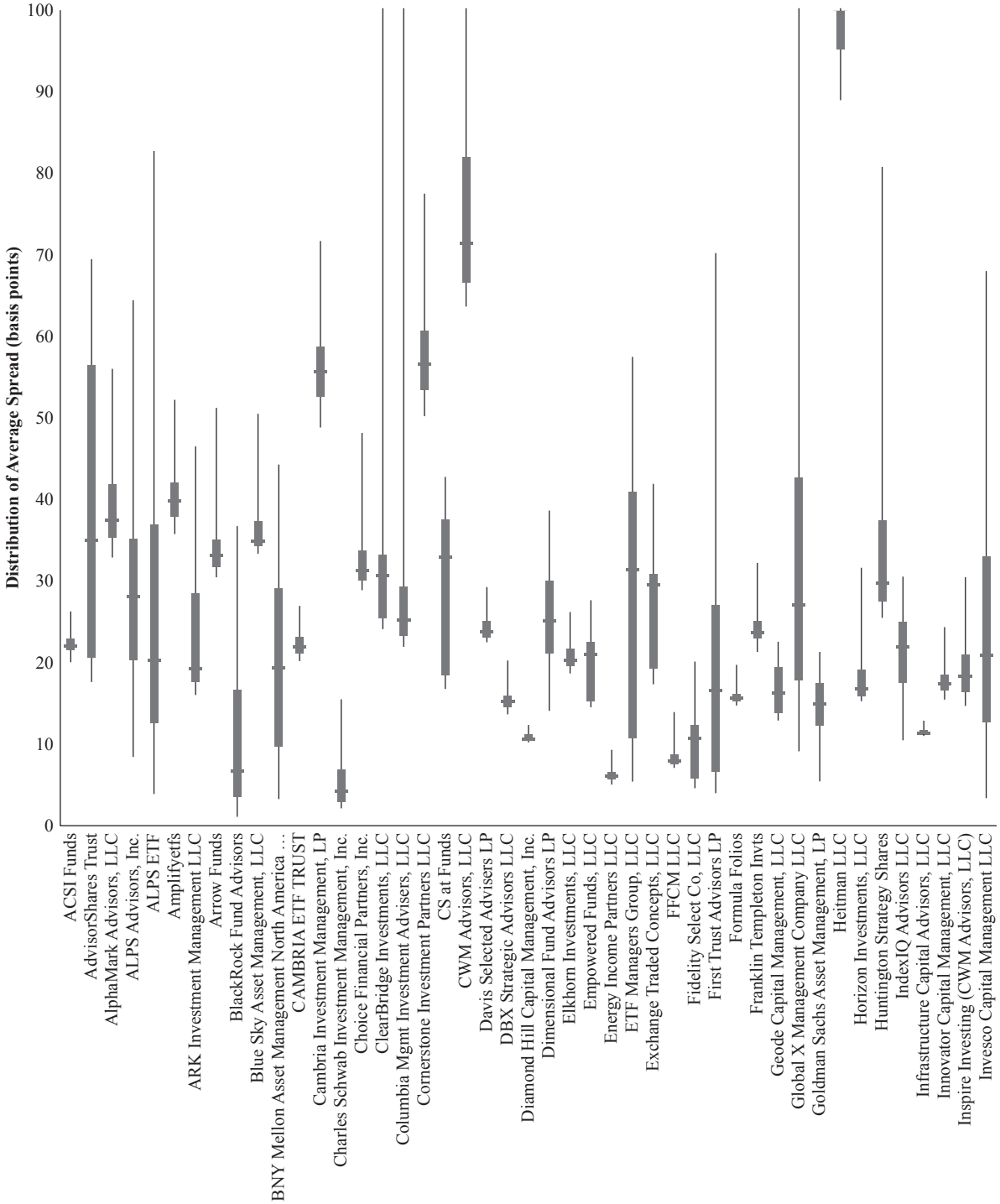
## Appendix A

**Average Bid/Ask Spread by Fund Issuer**




*(continued)*



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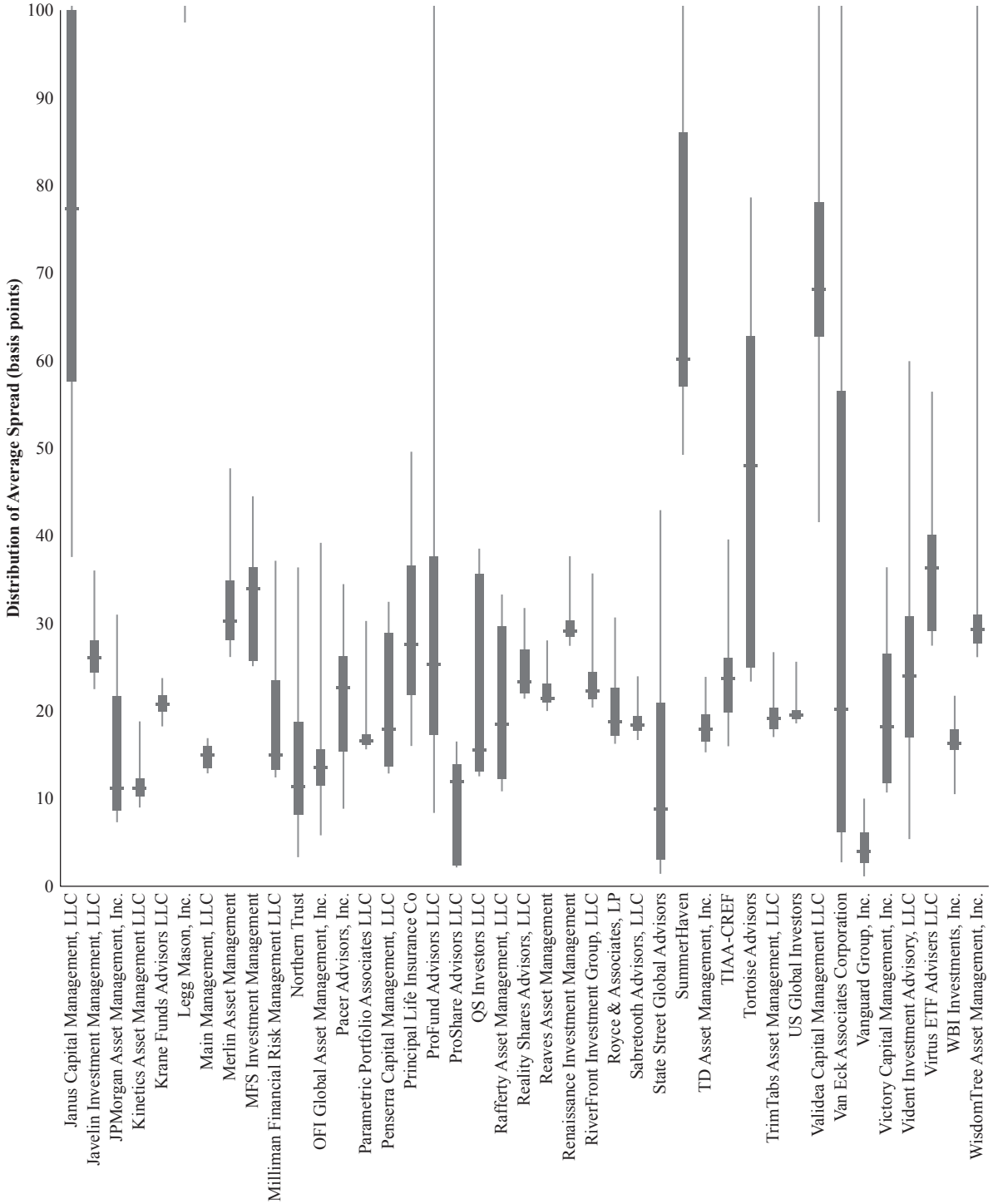
## APPENDIX A *(continued)*

**Average Bid/Ask Spread by Fund Issuer**




*Notes: This exhibit displays the distribution of average bid/ask spreads for each fund issuer as represented by the mean of each ETF's bid/ask spread in each of the 5-minute (78 total) intervals for all trading days in our 2017 sample. The boxes include the 75th to 25th percentile values; the whiskers extend to the 95th and 5th percentile values; and the dashes represent the median values.*

*Source: Authors' calculations, using data from OneMarketData LLC and Morningstar Inc.*



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