Examining the impact of reduced transaction costs and fractional trading to firm liquidity and ownership following stock splits

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I. Introduction

Fundamentally, stock splits are merely cosmetic corporate events bearing no impact on a firm's bottom line. However, previous literature has shown that these seemingly meaningless splits produce a tangible effect on investor sentiment. Despite the informative results of past literature, new developments surrounding stock splits, such as decimalization in 2001, the introduction of fractional share purchasing in 2019, and the elimination of transaction costs in 2019, have rendered these earlier results outdated, and their conclusions demand reconsideration. In this paper, I will outline the literature explaining the stock split rationale, examine the effects these events have, and present a model to analyze the change in liquidity, defined as the change in bid-ask spreads, trading volume, and firm ownership, in the wake of reduced transaction costs and fractional trading.

In response to empirical evidence that stock splits or announcements of a stock split result in abnormal price increases (Fama et al. (1969); Grinblatt et al. (1984); Ikenberry et al. (1996); Desai & Jain (1997)) and abnormal price decreases in response to reverse splits (Woolridge & Chambers (1983); Desai & Jain (1997) Kim et al. (2008)), academics began to question management's reasoning for splitting stocks. Previous literature has brought about two theses that explain corporate stock splits: the signaling hypothesis and the optimal trading range hypothesis.

The signaling hypothesis (Spence (1973); Riley (1979); Grinblatt et al. (1984); Asquith et al. (1989); McNichols & Dravid (1990)) posits that firm managers have private information about the future earnings of the firm and hold a positive outlook. The manager splits the stock with confidence that the stock will rise back to the pre-split price. Put simply, managers split their stock to convey positive private information about their firm to the public. Inversely,

managers who are pessimistic about the prospects of their firms are less likely to undertake a split (Grinblatt et al. (1984); McNichols & Dravid (1990)). While the signaling rationale also points to the existence of an optimal trading range, detailed further below, the early proponents of the hypothesis argued that a split was mainly private information driven.

The optimal trading range hypothesis postulates that managers split their shares because there is a range in which a stock trades best resulting from increased affordability (Baker & Powell (1993)), heightened trading volume (Ohlson & Penman (1985); Conroy et al. (1990); Koski (1995)), increased liquidity (Baker (1956); Lamoureux & Poon (1987); Copeland (1979)), and increased owner diversity (Mukerji et al. (2002); Szewczyk & Tsetsekos (1995)). As a result, when a firm's stock price grows out of this range, management is incentivized to split the stock to return to that range. This concept is in line with CFO sentiment; Baker and Gallagher (1980) surveyed CFOs of companies who have split stocks and found that 94% of them vouch for the optimal trading range as a determinant of their decision to split. Kinetik Holdings, one of the splits used in this study, announced it was splitting its stock on May 19th, 2022, and its press release declared, "the Company anticipates that the Stock Split will increase liquidity in the trading of the Company's stock and will make its stock more accessible to its employees and investors."[1] Furthermore, Mark Adams, CEO of SMART Global Holdings, Inc, notes of his company's split, "The two-for-one share split, which was approved by our board of directors, is a significant milestone for our Company and is intended to further improve our liquidity and broaden our shareholder base."[2] Many other observations used in this study point to a similar sentiment in their stock split press releases. It is also important to recognize that the optimal

[1] https://ir.kinetik.com/news/news-details/2022/Kinetik-Announces-Two-For-One-Split-of-its-Common-Stock/default.aspx
[2] https://ir.smartm.com/news/news-details/2022/SGH-Reports-First-Quarter-Fiscal-2022-Financial-Results/

trading range implicitly includes the signaling hypothesis. If a manager splits a stock to return to a better price, they must remain confident that the stock price will not decrease and fall out of the optimal range, as having too low of a stock price has negative implications (Grinblatt et al. (1984); McNichols & Dravid (1990)).

In this analysis, I focused primarily on the impact on liquidity, measured using firm ownership, bid-ask spreads, and trading volume, on October 2nd, 2019. The main reason for this isolation surrounds the coincidental occurrence of eliminated transaction fees and fraction share trading through brokerages on this date. The combination of these two events should have a measurable impact on a firm's liquidity. The introduction of fractional trading should have essentially eliminated the optimal trading range for investors using brokerages that offer fractional trading. However, it is worth noting that fractional trading was not made available to the entire population as only a small set of brokerages began offering the feature. However, given that many CFOs continued to cite enhanced liquidity as a primary reason for undertaking the stock split even after fractional trading's introduction, it remains an important factor to bring attention to. Stock splits present a fantastic avenue by which to measure the effects of increased liquidity because these events are already framed as liquidity accretive. Thus, measuring the change in liquidity following stock splits between the period before October 2nd, 2019, and afterward should allow us to quantify the impact of reduced transaction costs and fractional trading on liquidity.

To give context to our impact date, I detail the progression of reduced transaction costs. Robinhood, a user-friendly online brokerage, opened its doors in 2013 as the first firm in the market without transaction fees. This entrance was the beginning of the end for the incumbent brokers, and as Robinhood gained traction and users, larger firms responded by cutting trading

fees. The process did not happen overnight, but in the final hours of the 'race to zero,' Interactive Brokers drew first blood with its release of IBKR Light on September 26, 2019, a commission-free trading platform targeting small-cap retail investors. Within a few days, Charles Schwab, TD Ameritrade, and E*TRADE followed suit, eliminating transaction fees in dismay. While this trend reduced the upfront transaction fees charged, the brokerage houses attempted to make up for a portion of this lost revenue by betting on themselves.

Outside of the extinct, superfluous transaction fees, there are two ways in which brokerages can generate revenue from transactions: in a principal capacity and an agency capacity. In a principal situation, the brokerage house sells securities out of its inventory and charges a markup or mark-down on both buying and selling actions. For this strategy to work, brokers needed to purchase a stock for its inventory at market price and sell it to clients later at a market price higher than they bought it. However, the firms could easily lose money on this transaction if the inverse were to happen, and a stock price were to fall which they would recognize as a loss from selling to the customer. If the firm doesn't have the inventory of the trade, it acts in an agency capacity, connecting its client with a broker who does have the inventory. In this situation, the broker typically received a commission for connecting the buyer and seller; however, competition eliminated the commission-- transaction fees. Brokers turned primarily to open market operations—principal-based revenues—as well as alternative investment products to generate revenue.

In addition to this renewed business model, advances in computer technology—particularly on the Nasdaq Exchange—and the simultaneous introduction of fractional trading increased the speed at which transactions were completed. This led to a general uptick in

liquidity seen through reduced bid-ask spreads and increased share volume. These impacts can be seen in the dataset I employed to test my hypotheses in Figure 1.

Here, the average daily bid-ask spread including firms from both the control and treatment group possess an average of .0046 before October 2nd, 2019, and .0044 following indicating a reduced average bid-ask spread following the introduction of fractional trading and reduced transaction costs. I found a similar effect in daily average volume figures displayed in Figure 2, where volume grows from 1,009,118.6 before October 2nd, 2019, to 1,037,994.9, following. These two statistics provide evidence of increased liquidity in wake of transaction fee slashing. Further, it is worth noting that the introduction of fractional share trading on the same date as eliminated transaction cost should only exacerbate the liquidity effect further reducing bid-ask spreads and increasing volume under the affordability argument.

The elimination of transaction costs is significant to the previous literature in that transaction costs are a lever in most studies about the impacts of stock splits. The lower price per share following a split has several consequences related to liquidity, often measured using the bid-ask spread and trading volume, and firm ownership, the key proxies used in this study.

Stock splits increase the proportional bid-ask spread according to Copeland (1979), yet Conroy et al. (1990) conclude that stock splits have a statistically significant effect on reducing bid-ask spreads. Further, Benston & Hagerman (1974) found that the bid-ask spread is inversely related to price, implying that with the reduced stock price from a split, bid-ask spreads will increase following a split. The bid-ask spread is created from market makers placing quotes at a price at which they would buy and sell certain securities. Each market maker is required to place a two-sided quote on both the Nasdaq and NYSE meaning they must post a price at which they would buy and sell the security. Naturally, firms look to secure the best deal. The difference

between the highest bid and the lowest ask is called the bid-ask spread. When there are many market makers submitting quotes on a single security, the bid-ask spread narrows as the additional market makers fill the quotes that were previously further apart. Thus, the narrower the bid-ask spread is, the more liquid the firm's stock is. Following the elimination of transaction fees, brokerage platforms such as Robinhood have turned to the bid-ask spread to generate most of their revenue, but with fractional trading accompanying this change, liquidity is expected to increase dramatically as affordability is essentially removed as a factor to clients of brokers who offer the service. As a result, I expect to see a significant reduction in bid-ask spreads in the wake of stock splits following the extinguishment of transaction fees and beginning of the fractional trading.

In addition to bid-ask spreads, trade volume is another proxy for liquidity studied in tandem with stock splits. Anshuman and Kalay (1997) proposed that because stock splits increase the economic significance of the minimum tick, relevant before decimalization, they also affect the economic incentives of some classes of market participants, which result in an inverse relationship between the coefficient of intraday trading volume and price level. Tauchen and Pitts (1983) explored the relationship between price and volume through the lens of speculative markets noting that lower prices may lead to increased noise traders in the market. Ohlson and Penman (1985) found that a stock's returns show greater volatility after a split and surmise (citing private communication with Fischer Black) that the lower stock price attracts noise traders, who cause greater volatility. Lamoureux and Poon (1987) proposed that the greater post-split volatility increases the value of the tax-trading option, which leads to a higher stock price. Further, the study concluded that there was an increase in trading activity, both transactions and the number of shares traded, which increases the volatility in returns. Without

transaction fees, I expect to see this effect exacerbated, resulting in heightened volume. Further, the increased affordability made possible by fractional trading should increase volume post-split.

The final element of this study concerns shareholder makeup. Mukherji et al. (2002) analyzed the impact of stock splits on firm ownership using all stock splits of 25% or more by NYSE- and AMEX- listed firms from 1984 through 1988, and the researchers find that stock splits increase the number of both individual and institutional shareholders, but do not affect the proportion of equity held by institutions. Benston and Hagerman (1974) found a negative cross-sectional relationship between the number of stockholders and stocks' bid-ask spreads. Amihud et al. (1999) used the Japanese equity markets and the reduction of minimum trading units, more relevant before decimalization, to find that a reduction in the minimum trading unit increased a firm's base of individual investors and its stock liquidity. Further, a reduction in the minimum trading unit was associated with a significant increase in the stock price. Dennis and Strickland (2003) found institutional ownership grew the most post-split when there was lower institutional ownership pre-split, liquidity was negatively related to institutional ownership pre-split, and abnormal returns were negatively related to institutional ownership pre-split. Without transaction fees to retail investors and the ability to trade fractional shares, I expect to see the proportion of institutional ownership decrease following stock splits.

I also provide background on transaction costs research and their role in the current study. Brennan and Hughes (1991) suggested that because brokerage commissions increased with the number of shares traded, stock splits increased brokers' revenues for a given dollar amount traded and consequently induced information gathering by investment analysts in brokerage firms about companies that split their stock. This motivated managers with favorable information about their companies to split their shares and bring about a positive price reaction.

Smith et al. (2004) confirm that splitting a stock increases the percentage of profits for market makers.

In this paper, I plan to employ a Difference-in-Difference framework to compare the changes to stocks' liquidity proxied by bid-ask spreads, trade volume, and firm ownership in the wake of zero transaction fees and fractional trading before and after October 2nd, 2019. From this analysis, I hypothesize that bid-ask spreads will narrow, trading volume will expand, and institutional firm ownership will decline following stock splits after the introduction of fractional trading and the elimination of transaction fees.

II. Data & Empirical Framework

To complete my analysis, I compiled a list of all 2-for-1 stock splits made by firms trading on the New York Stock Exchange ("NYSE") or Nasdaq from April 10th, 2016, through December 31st, 2022. This range was selected to balance the amount of time before and after October 2nd, 2019, the transaction fee elimination, and the fractional trading introduction date. I restricted my sample to 2-to-1 splits to avoid confounding factors that impact split decisions. For example, the NYSE prohibits firms from falling below $5.00 per share. In response to this, firms commonly conduct a reverse split to remain above the threshold. Another example consists of a split to merge with another company. While this merger or acquisition could be interpreted as "good news," I eliminated such cases to isolate observations that were considered voluntary and fulfill the optimal trading hypothesis. Further, I eliminated any exchange-traded fund ("ETF") splits as managers of ETFs theoretically have no insider information as they are stock pickers as opposed to managers and usually have a different shareholder composition than a typical manager-operated firm. While this may point to the affordability rationale for these splits, given

the previously established interconnected nature of the signaling and optimal trading range hypotheses, I found it best to exclude ETFs for this analysis. Although I acknowledge the validity of the argument for including ETFs in this study, I elected to exclude them to isolate operating managers' decisions. The original list of stock splits contained 77 splits with the final list numbering 68. I was forced to eliminate 9 observations due to the inability to identify split announcement dates or the unavailability of necessary data. To enrich the dataset, I pulled split announcement dates, daily closing bids, daily closing asks, and daily trading volume from the Center for Research in Security Prices ("CRSP") database. For the split announcement dates, I confirmed each date with company press releases. If the company did not have an associated press release, the observation was excluded. After this, I pulled and confirmed the announcement dates, I adjusted the dates to reflect the day on which the announcement should be reflected in the company's stock price. For example, if a company announced the split on a Friday, weekend, or holiday, I adjusted the date to reflect the following Monday or subsequent day of trading. I gathered historical quarterly company ownership information from Capital IQ. The only data available for company ownership was the percentage of the company owned by institutional investors (defined as any money manager with an AUM greater than $50 million) on a quarterly basis. Turning to Mukherji et al. (2002), having the number of institutional versus retail investors, as well as monthly data, would have provided a more complete analysis; however, this data was unavailable.

To ascertain the effects of eliminated transaction costs and fractional trading on splitting companies, I built an original control group. The control group was constructed on an observation-by-observation basis to control for factors including company size and industry. This method was used to control for industry fluctuations and size premiums. To identify this

control group, I used a similar method to that found in Mukherji et al. (2002). In that study, the researchers primarily used SIC codes and total assets within 25% of the splitting company in the year before the split to create their control group. I altered this approach to screen companies based first on the industry, but in place of total assets in the prior year, I used market capitalization in the year of the split. If this screen produced multiple companies, I then used total assets in the year before the split as a final variable. Given the reliance of the optimal trading range and liquidity on investor sentiment, I found market capitalization, controlled by market sentiment, to be a better measure of company size than assets for this analysis.

I prioritized industry over market capitalization and total assets when selecting control companies. For example, Silgan Holdings (NYSE: SLGN) operates in the 'Metal Cans' industry, SIC code number 3411, and has a market capitalization of 3,202 in 2017, the year of its split on 5/13/17. There are only four companies with a 3411 SIC code, and the closest one in terms of assets is Crown Holdings, Inc. (NYSE: CCK) with a market capitalization of 7,493 in 2017. Despite its significantly larger market capitalization, I selected the company to hold the industry constant. This method was used for the entire control group giving priority to the

Table 1: Summary Statistics

	Splitting Firms	Control Firms
Observations	68	62
Median Market Capitalization	2523.0	1797.9
Average Market Capitalization	9494.6	7357.1
Median Total Assets	1437.0	1780.3
Average Total Assets	8250.9	6788.1
Median proportion of equity held by institutions (%)	71.9%	76.6%
Average proportion of equity held by institutions (%)	66.4%	66.6%

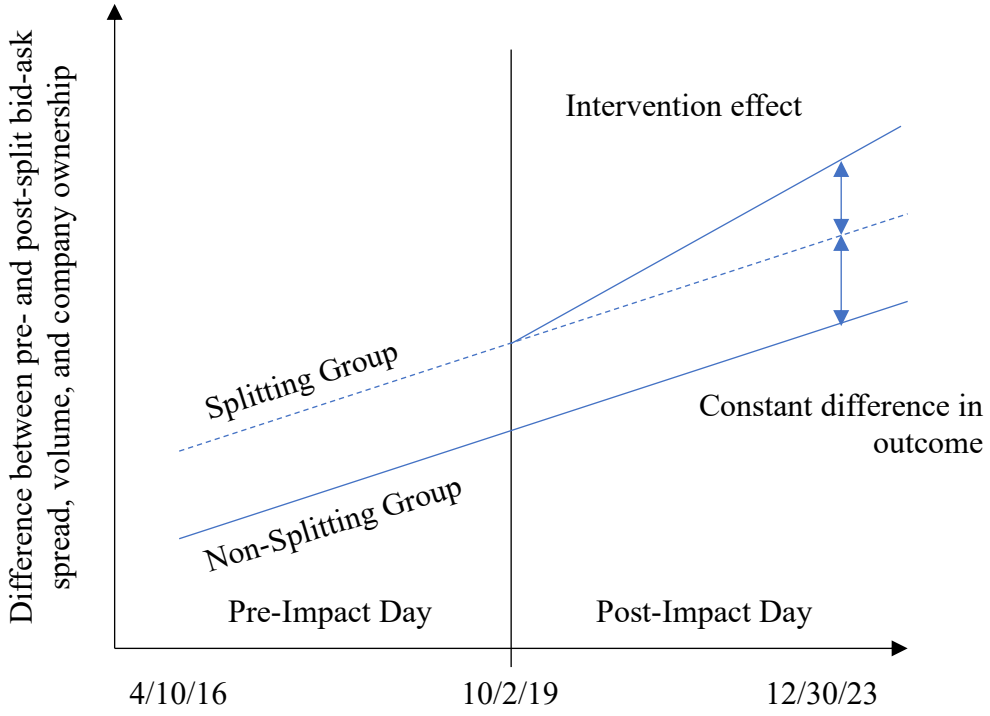
*Market Capitalization and Institutional Ownership are taken from year or quarter of the split. Total Assets are taken from year before split.

industry and, if possible, controlling for market capitalization and total assets, as well. Summary statistics of the control and treatment groups can be found in Table 1. After pulling the relevant data, I calculated the daily bid-ask spread using the closing bid and ask with the following equation:

$$\frac{(Closing\ Ask - Closing\ Bid)}{Closing\ Ask}$$

From here, I pulled the closing bid-ask spread and volume numbers 7 days before and following the split announcement date for each splitting and their associated control firms. I examined the percent difference between the seven, five, three, and single-day trailing and forward averages and medians using a Difference-in-Difference ("Diff-in-Diff") framework. For context, comparing the 7-day trailing average to the forward average for bid-ask spreads would involve calculating the average of the bid-ask spread for the 7 days before the split from day -7 to -1. The forward average number was calculated by taking the average of the 7 days after the split,

Figure 1: Visualization of Diff-in-Diff framework



including the announcement date, days 0 to 6. From here the percent change in the two numbers was calculated between the two figures using the equation below.

$$\frac{(Forward\ Average - Trailing\ Average)}{Trailing\ Average}$$

The same equation was used to find the percent change for the remaining periods and volume figures.

For institutional ownership, I took the percent change in quarterly ownership between the announced quarter and the quarter before. The goal of the Diff-in-Diff analysis is to identify the unique effect of the reduced transaction costs and fractional trading on stock splits compared to non-splitting firms, as visualized in Figure 1. To further explain how the difference in difference applied to this situation, I have explained each variable as depicted in Figure 1. Our effect group, a group of firms that have undergone a 2-to-1 split after April 10th, 2016, will be compared to our control group, defined as a group of firms of a similar size in the same industry that has not split. Both groups underwent the treatment, on October 2nd, 2019, when transaction costs at most major brokerage houses were eliminated and several brokerage houses began to offer fractional share trading. The intervention effect, as seen in Figure 1, will define the excess effect that no transaction costs and fractional trading will have on splitting firms. My treatment group has 24 splits that take place after October 2nd, and 44 that take place before. Below is the regression equation:

$$y_{it} = \beta_0 + \beta_1 S_i + \beta_2 T_t + \beta_3 (T_t * S_i) + u_{it}$$

In the equation, y_{it} is the percent difference in bid-ask spread, company ownership, or trading volume between the splitting company and the control company. S_i represents a dummy variable that distinguishes a splitting firm from a non-splitting firm. T_t represents a dummy variable that distinguishes whether the split occurred before or after the treatment date, October 2nd, 2019. (T_t

* S_i) is the interaction term between the two previously described dummy variables, and identifies the effect that the treatment, zero transaction costs and fractional trading, has on y_{it}.

III. Results

Before I dive into my regression results, I will share some simple statistics about my sample. Table 2 holds the difference between the splitting and non-splitting firms' percent change in bid-ask spread before and after the respective split dates. The Dataset Average and Median columns are calculated by taking the median or average of all splitting and non-splitting firms' percent change in the bid-ask spread. The rows indicate each of the different time periods used in calculating each percent change in the bid-ask spread. For example, the 5-day Median row indicates that the bid-ask spread consists of the percent change between the trailing 5-day median and the forward 5-day median. The difference columns are calculated by subtracting the Non-Splitting Firms from the Splitting firms. Thus, a negative value in the difference column indicates that on average or median the splitting firms saw a more compressed bid-ask spread than their non-splitting counterparts. This provides a high-level view of the difference in bid-ask spread between splitting versus non-splitting firms. On the average side, bid-ask spreads appear

Table 2: Percent Change in Bid-Ask Spreads, Splitting and Non-Splitting Firms

	Dataset Average			Dataset Median		
	Splitting Firms	Non-Splitting Firms	Difference	Splitting Firms	Non-Splitting Firms	Difference
7-day Average	0.081	0.063	0.017	-0.034	0.000	-0.033
7-day Median	0.187	0.181	0.006	-0.034	0.004	-0.038
5-day Average	0.115	0.001	0.114	-0.006	-0.036	0.031
5-day Median	0.096	0.153	-0.057	-0.018	-0.011	-0.007
3-day Average	-2.155	-2.002	-0.153	-1.996	-1.979	-0.017
3-day Median	0.311	0.125	0.186	-0.002	-0.012	0.010
1-day	0.170	0.419	-0.249	-0.013	-0.005	-0.007

to be wider for the splitting firms, which is highly unexpected. This outcome is assumed to be the product of a few outlying observations that skew the average numbers up. Further, the average numbers detail the splitting firms to have a percent increase in bid-ask spread, withholding the 3-day Average row, a highly unexpected outcome. When analyzing the median side of the table, the difference column remains mostly negative, which is in line with expectations.

Table 3 provides the difference between the splitting and non-splitting firms' percent change in volume before and after the respective split dates. The numbers are calculated in the same fashion as Table 2. In this table, we are expecting trading volume to increase in splitting firms compared to non-splitting firms. As a result, we expected to find positive values in the difference column. All the difference columns in Table 3 are positive indicating that across all time frames, on average or median, splitting firms find a high trading volume than non-splitting firms.

Table 3: Percent Change in Volume, Splitting and Non-Splitting Firms

	Dataset Average			Dataset Median		
	Splitting Firms	Non-Splitting Firms	Difference	Splitting Firms	Non-Splitting Firms	Difference
7-day Average	0.566	0.196	0.370	0.253	0.005	0.248
7-day Median	0.728	0.040	0.687	0.244	-0.081	0.326
5-day Average	0.934	0.245	0.689	0.260	0.069	0.191
5-day Median	2.292	0.088	2.204	0.379	-0.014	0.394
3-day Average	0.817	0.235	0.581	0.338	-0.067	0.405
3-day Median	4.400	0.175	4.225	0.441	-0.006	0.447
1-day	0.657	0.268	0.389	0.064	-0.021	0.084

Similarly, Table 4 provides the breakdown of the percent change in institutional ownership between splitting and non-splitting firms. While splitting firms had a much lower

Table 4: Percent Change in Institutional Ownership, Splitting and Non-Splitting Firms

	Splitting Firms	Non-Splitting Firms	Difference
Average Institutional Ownership	0.002	0.046	-0.044
Median Institutional Ownership	-0.002	0.001	-0.003

percent change in institutional ownership compared to non-splitting firms, the effect was very small and only negative in one case. Despite the small effect, this result is in line with previous literature, Mukherji et al. (2002) found that stock splits had no effect on the ratio of institutional to retail ownership.

Next, I present Table 5 and Table 6 which hold the average percent change in bid-ask spread and volume before and after October 2nd, 2019, the date of transaction cost elimination and fractional trading. I included these two tables to display the reduced bid-ask spread and increased trading volume that accompanies the interaction date. Table 5 holds the percent change in the bid-ask spread. Among splitting firms, across almost every period, bid-ask spreads grow significantly narrower following the interaction date, which is in line with expectations. Despite this finding, most of the post-October 2nd, 2019, numbers remain positive indicating that bid-ask spreads are still rising which counters my original thesis, the increased liquidity from the zero transaction fees and fractional trading would reduce bid-ask spreads.

Table 5: Average Percent Change in Bid-Ask Spread, Splitting Firms, before and after the interaction date.

	Before Oct 2nd 2019	After Oct 2nd 2019	Difference
Bid Ask Spread 7-day Average	0.105	0.036	-0.068
Bid Ask Spread 7-day Median	0.121	0.310	0.189
Bid Ask Spread 5-day Average	0.200	-0.040	-0.240
Bid Ask Spread 5-day Median	0.122	0.047	-0.075
Bid Ask Spread 3-day Average	-2.238	-2.002	0.236
Bid Ask Spread 3-day Median	0.457	0.044	-0.413
Bid Ask Spread 1-day	0.220	0.078	-0.141

Table 6: Average Percent Change in Volume, Splitting Firms, before and after the interaction date.

	Before Oct 2nd 2019	After Oct 2nd 2019	Difference
Volume 7-day Average	0.463	0.756	0.294
Volume 7-day Median	0.467	1.205	0.738
Volume 5-day Average	0.635	1.482	0.847
Volume 5-day Median	2.697	1.550	-1.146
Volume 3-day Average	0.792	0.863	0.071
Volume 3-day Median	6.235	1.037	-5.198
Volume 1-day	0.758	0.475	-0.283

The volume figures in Table 6 remain mostly in line with expectations with most of the difference columns being positive, signaling that trading volume typically jumps for splitting firms after the interaction date. A few of the before October 2nd, 2019, numbers are extraordinarily large which is likely due to an upward skew by several observations. This is expected when using the average instead of the median numbers. Meanwhile, Table 7 holds the data for institutional ownership. Contrary to expectations, institution ownership rose following the interaction date.

Table 7: Average Percent Change in Institutional Ownership, Splitting Firms, before and after the interaction date.

	Before Oct 2nd 2019	After Oct 2nd 2019	Difference
Institutional Ownership Average	0.007	0.016	0.009

Bearing these simple statistics in mind, I present my regression results. To test my hypothesis, which surmised that following the ample liquidity offered by reduced transaction costs and the introduction of fractional trading on October 2nd, 2019, stock splits would see a reduction in bid-ask spread, increase in trading volume, and lower institutional ownership following their stock split, I ran a series of difference-in-difference regressions with the percent change in bid-ask spread, volume, and institutional ownership across various periods as the dependent variable. Table 8 holds the regression results for the bid-ask spread.

Upon initial review of the table, it is apparent that significance is sparse. Further, upon review of the R-squared values, there is clearly little explanatory power within these regressions. Despite these shortcomings, there is still much to interpret surrounding these graphs. Within the FirmSplit column, there are two instances of significance; however, each coefficient is equally powerful, moving in the opposite direction. Most of the Diff_in_Diff terms are negative indicating that, although weak and only statistically significant in one instance, the interaction

date did tighten bid-ask spreads. Unsurprisingly, the afterOct2nd was never statistically significant and was positive for most of the regressions. While this ran contrary to expectations, based on the summary statistics previously provided, it makes more sense.

Table 8: Regression Result for Bid-Ask Spread

Dependent Variables	afterOct2nd	FirmSplit	Diff_in_Diff	R-squared
BidAsk7dayAvg	0.0882	0.0726	-0.1564	0.0061
	[0.487]	[0.496]	[0.384]	
BidAsk7dayMed	0.1053	-0.0237	0.0842	0.0071
	[0.638]	[0.900]	[0.790]	
BidAsk5dayAvg	0.1105	0.2378**	-0.3503*	0.0369
	[0.430]	[0.044]	[0.078]	
BidAsk5dayMed	0.0862	0.0000	-0.1617	0.0041
	[0.656]	[1.000]	[0.555]	
BidAsk3dayAvg	-0.0638	-0.2589*	0.2995	0.0298
	[0.700]	[0.065]	[0.203]	
BidAsk3dayMed	-0.0340	0.3197	-0.3791	0.0143
	[0.925]	[0.291]	[0.457]	
BidAsk1day	0.4226	-0.0503	-0.5640	0.0166
	[0.278]	[0.877]	[0.306]	

* Significance at the 10% level

** Significance at the 5% level

*** Significance at the 1% level

Table 9 reflects the regression results of the trading volume. A similar lack of significance accompanies the volume regressions. However, there is still meaning to be found. As expected, all the data points in the FirmSplit column are positive indicating that volume increases in the wake of a stock split. Interestingly, the afterOct2nd regressor is completely negative which is contrary to the summary statistics which saw mostly positive percent change following the interaction date. The Diff_in_Diff term was positive in five of seven regressions with two being statistically significant at the 10% level, indicating that volume was increased for stock splits in the wake of the interaction date.

Table 9: Regression Results of Trading Volume

Dependent Variables	afterOct2nd	FirmSplit	Diff_in_Diff	R-squared
Vol7dayAvg	-0.1943	0.1977	0.488	0.0409
	[0.480]	[0.392]	[0.210]	
Vol7dayMed	-0.2706	0.3311	1.009*	0.0671
	[0.518]	[0.347]	[0.090]	
Vol5dayAvg	-0.4294	0.2388	1.2767*	0.0556
	[0.392]	[0.571]	[0.073]	
Vol5dayMed	-0.1897	2.5417	-0.9565	0.0192
	[0.930]	[0.162]	[0.754]	
Vol3dayAvg	-0.4307	0.4045	0.5015	0.0539
	[0.223]	[0.174]	[0.315]	
Vol3dayMed	-0.3073	5.9515	-4.8909	0.0174
	[0.954]	[0.186]	[0.517]	
Vol1day	-0.4442	0.3332	0.1614	0.0133
	[0.449]	[0.501]	[0.846]	

* Significance at the 10% level

** Significance at the 5% level

*** Significance at the 1% level

Table 10 reflects the regression results for institutional ownership. For this regression, because there was only quarterly data available, I elected to run two different regressions. The first, CompOwn0, used the quarter of the split announcement as the post-split number. Thus, the number reflected the percent change in institutional ownership between the quarter before the split and the quarter of the split. The second, CompOwn1, used the quarter of and the quarter after the split announcement. In this regression, the dependent variable is composed of the percent difference between the quarter of the split announcement and the antecedent quarter. Unsurprisingly, we do not find significance. Without more nuanced data, this regression struggles to communicate any meaning. Despite its limitations, the regression did find both

afterOct2nd and FirmSplit to reduce institution ownership, but the diff_in_diff term remains positive. Regardless of the directions of the coefficients, there is no significance.

Table 10: Institutional Ownership Regression Results

Dependent Variables	afterOct2nd	FirmSplit	Diff_in_Diff	R-squared
CompOwn0	-0.0057	-0.0110	0.0148	0.0011
	[0.877]	[0.721]	[0.776]	
CompOwn1	-0.0445	-0.0569	0.0356	0.0163
	[0.411]	[0.211]	[0.642]	

* Significance at the 10% level

** Significance at the 5% level

*** Significance at the 1% level

A few commonalities arise from these regressions. First, of the four statistically significant regressors only one of them is inside the three-day period. This is unexpected but makes sense as there are common instances in which investors do not take news into account immediately. In this study, it would make sense that investors may not appreciate the stock split announcement, or even see it, until a few days after it has been announced. This effect is hard to measure. In an effort to adjust for this effect, I ran another series of regressions on bid-ask spread and volume, only I move the date of the split forward one day. The results of these regressions can be found in Table 11, bid-ask spread, and Table 12, trading volume. Neither regression presents an improved analysis as most coefficients remain pointed in the same direction, and most of the significance is lost.

To conclude, in the regressions testing the impact of reduced transaction costs and fractional trading on stock liquidity, I found significance across a few time periods, particularly on the difference-in-difference regressor and the firm split for bid-ask spread and trading volume.

Table 11: Bid-Ask Spread Regression Results, Split Date + 1

Dependent Variables	afterOct2nd	FirmSplit	Diff_in_Diff	R-squared
BidAsk7dayAvg	0.0868	0.0680	-0.2306	0.0114
	[0.529]	[0.556]	[0.237]	
BidAsk7dayMed	0.0678	0.1118	-0.1252	0.002
	[0.795]	[0.611]	[0.735]	
BidAsk5dayAvg	0.0241	0.1784	-0.3123	0.0066
	[0.877]	[0.173]	[0.157]	
BidAsk5dayMed	-0.0969	0.1667	-0.2421	0.0183
	[0.684]	[0.405]	[0.472]	
BidAsk3dayAvg	-0.0358	-0.2309	0.2575	0.0245
	[0.831]	[0.104]	[0.280]	
BidAsk3dayMed	-0.0978	0.1998	0.0783	0.0109
	[0.737]	[0.414]	[0.849]	
BidAsk1day	0.3216	0.5412	0.1581	0.006
	[0.552]	[0.236]	[0.837]	

Table 12: Volume Regression Results, Split Date + 1

Dependent Variables	afterOct2nd	FirmSplit	Diff_in_Diff	R-squared
Vol7dayAvg	-0.1708	0.0503696	0.3920315	0.0228
	[0.449]	[0.790]	[0.220]	
Vol7dayMed	-0.3041	0.3038	0.9571	0.0582
	[0.468]	[0.388]	[0.107]	
Vol5dayAvg	-0.2576	0.4757	0.4757	0.0261
	[0.325]	[0.742]	[0.199]	
Vol5dayMed	-0.3365	2.4008	-1.3006	0.0183
	[0.875]	[0.183]	[0.666]	
Vol3dayAvg	-0.4559	0.0417	0.5256	0.0316
	[0.100]	[0.857]	[0.179]	
Vol3dayMed	-0.2387	0.4493**	-0.0194	0.0221
	[0.314]	[0.026]	[0.954]	
Vol1day	-0.3298	0.2146	0.2574	0.0225
	[0.314]	[0.436]	[0.577]	

IV. Discussion

I found a few instances of significance in my analysis supporting my hypotheses. First, I found a difference-in-difference term with a negative coefficient to be statistically significant at the 10% level. The negativity of the coefficient implies that bid-ask spreads have narrowed in the wake of our interaction day, October 2nd, 2019. Further, I found statistical significance in my set of regression measuring trading volume. In this set of regressions, I found two instances of statistical significance at the 10% level, both on the difference-in-difference regressor. The coefficients of both regressors were positive signaling that volume increased following stock splits after the interaction date. All the significance found for the difference-in-difference estimators were relegated to the longer time period which indicates one of two things. First, there is a lag effect in response to stock splits and bid-ask spreads and trading volume only changes a few days post-split or there were a few outliers within the time frames that were found to be statistically significant which propelled the respective terms to significance. Given that only a few regressions produced significant outcomes, it is hard to award real value to these findings. When comparing the results of the bid-ask spread regressions to the trading volume regression, bid-ask spreads rely on many more factors than trading volume. The R-squared numbers for the regressions are much higher for trading volume, albeit they are still very low.

I previously mentioned the issues with the Company Ownership data. I did not expect to find significance in this regression analysis due to the lack of nuanced data. While access to this data was limited, I was excited to explore this proxy for liquidity as the introduction of fractional shares, surely would have a tangible impact on company ownership makeup. This is a subject of study that I would recommend scholars explore more in the future.

One large item that I think would vastly improve this experiment surrounds the construction of the control set. In my methodology, I described how I picked a single company to compare each split too. As seen in the large swings in results and abnormal regression coefficients, the outliers in the data blew holes in this analysis. My next step would be to create a portfolio of several stocks within the same industry that combined have an average and median market capitalization and total assets that are within a certain range of the splitting company's figures. This method would provide a more realistic comparison of the splitting company to the market. Using single companies invites an element of randomness which can have a large effect on a study with a limited number of observations, such as this one.

Another interesting experiment that may prove to be worthwhile is an isolated study using the same method but focusing primarily on ETFs. Theoretically, because ETFs are passively managed, and do not possess any insider information, the only explanation that an ETF manager could have would be the optimal trading range or affordability. Obviously, the introduction of fractional trading would have massive implications for this theory.

To conclude, I was able to find sparing statistical significance in my series of regressions; however, the significance I found provided evidence for my hypotheses. I found that bid-ask spreads narrowed, and trading volume increased because of eliminated transaction costs and the introduction of fractional trading. Despite this significance, I ran a superfluous amount of regression of which any could have produced significance; as a result, due to the rarity of statistical significance, these results must be taken with a grain of salt.

V. Appendix

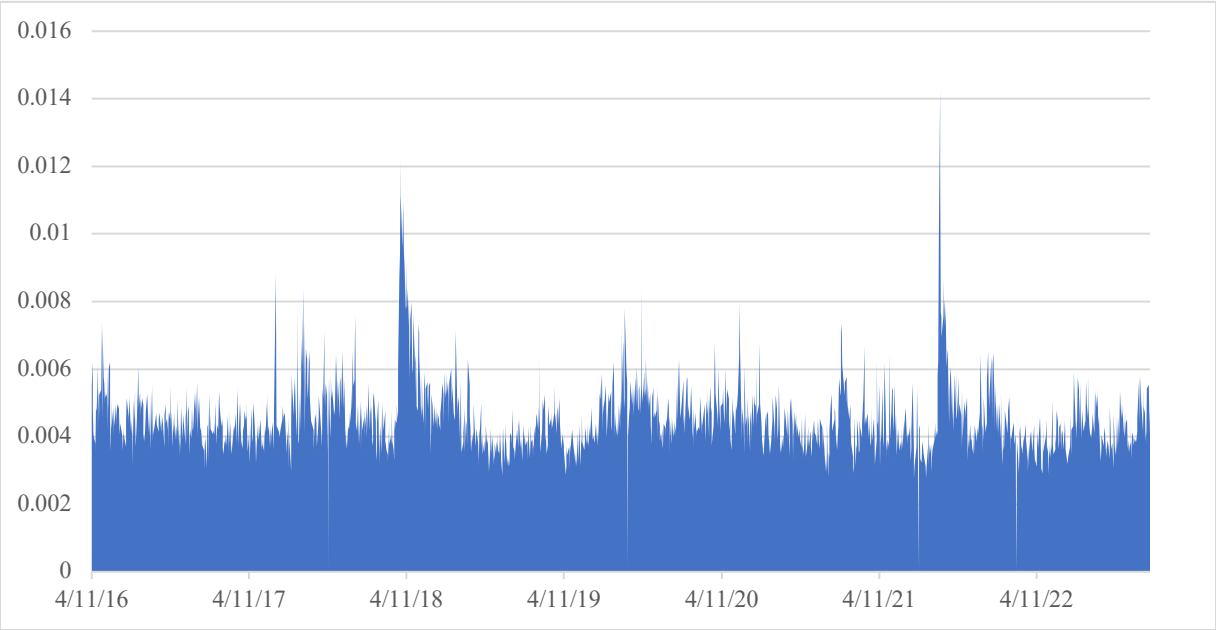


Figure 1: Daily Average Bid-Ask Spread for Splitting and Non-Splitting Groups

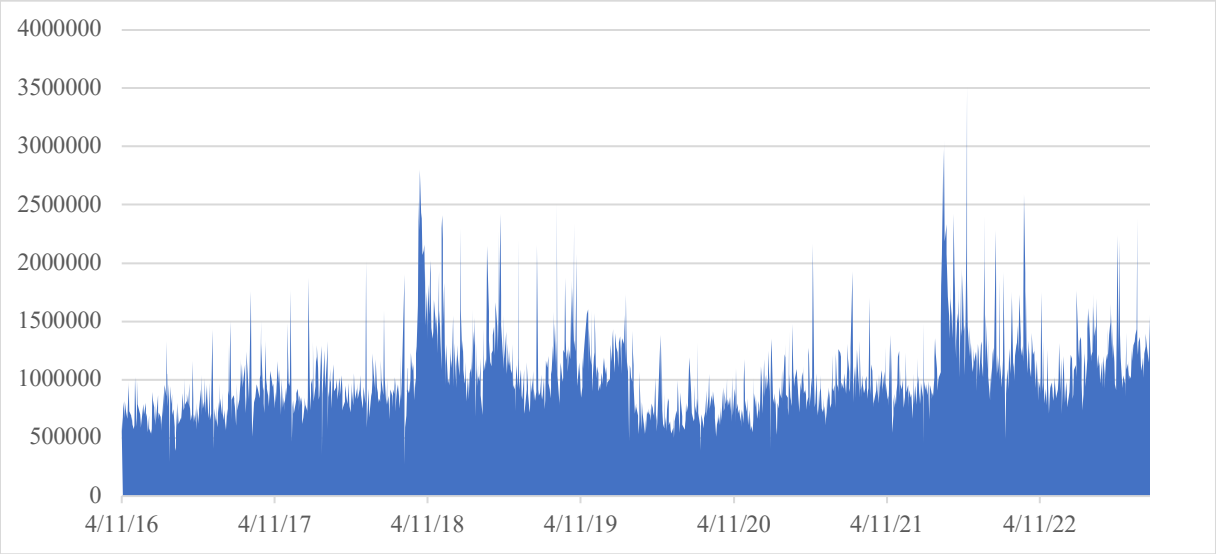


Figure 2: Daily Average Volume for Splitting and Non-Splitting Groups

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