Effects of Changes in Interest Rates on Exchange Trade Funds Liquidity

Master Thesis

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Abstract

Using daily data over the period for 01/03/2006 to 06/29/2018, this paper investigates the effects of changes in interest rates on the liquidity of exchange-traded funds. We use quoted spreads, effective spreads, Amihud illiquidity and trading volume as proxies of ETF liquidity. The liquidity proxies are regressed with short rates, term spread, quality spreads, volatility index. We first found that on average the spreads of ETFs are relatively small. Second, we found a statistically significant negative relationship between interest rates and liquidity of ETFs, also volatility to the liquidity of ETFs. Third, we found that trading volume is negatively associated with interest rates. Finally, we found that trading volume is positively affected by monetary policy announcements, on the days leading to the announcement day and on the announcement day.

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Contents

1. Introduction

Exchange-traded funds have become the most popular passive investment vehicle in recent years compared to other traditional index funds. After 2006 the creation of these funds rose by a significant amount, gaining a lot of attention from investors. The exchange-traded funds have given rise to many questions, i.e. what makes them unique to other funds? Investors use these funds for various reason such as; speculation, hedging, and have attracted many uninformed investors wishing to partake in the market invest in these funds, they are cheaper than other funds and last but not least they are used for liquidity purposes. In this paper, we will look at the liquidity of exchange-traded funds. Many studies that have been done on ETFs have mostly been about the specific features that ETFs have compared to other index funds and mutual funds. However, the liquidity of ETFs have been studied but further research is still needed to identifying other factors affecting ETF liquidity. Richards (2007) writes about how the liquidity of ETFs is created by the Authorise participants and the sponsors of the ETFs. Previous studies have identified possible factors of ETF liquidity and concluded that they are; the liquidity of the underlying assets of the ETFs, the market index volatility underlying the ETF, trading activity, size of the ETFs, Funding cost, availability of (futures) hedge. In this paper, we are interested in studying the interest rates effect on liquidity of exchange-traded funds. We investigate the relationships and the magnitude of this effect by looking at different sectors of ETFs.

In recent years the markets have experienced a global financial crisis in 2007/08 and we have witnessed the ETF's liquidity plunged in response to market distress. During this period interest rates dropped to significantly low levels closer to zero and since then they have been historically low. The ETF spreads have been lower also. We have observed the reaction of the ETFs during the time of financial distress (2007/08) and following the years of financial crisis since 2006 many of ETFs were created and they have managed to reach an AUM over trillions of dollars. This sudden increase in ETFs have raised questions amongst market participants if the funds are a bubble in the making or not? Since these questions are still being asked it means that there is a lot that we still need to learn about these products.

In late 2015 the Federal Reserve Bank implemented monetary policy regime by increasing the policy rate (Federal funds rate). We have developed interest on studying the effects of changes in interest rates on the liquidity of ETFs since the interest rates have been increasing, this

phenomenon has not received attention and this means that there is room for future academic research. This paper will contribute to existing research of liquidity factors by giving some insight on this under-researched portion of ETFs. The economic intuition is that we have realised the effect of interest rates when they are declining, the spreads of ETFs are increasing during this period, and however, we would expect the opposite reaction when interest rates are increasing. Furthermore, we have found that is not the case, the spreads also increase on average with an increase in interest rates. The study will answer the questions on how ETFs liquidity response to interest rates i.e. the rise of interest rates to be exact, is this reaction in the long run or short run, and how are the interest rates sensitive sectors of ETF affected? The objectives of the study are to identify liquidity measures of ETFs, estimate the effect of interest rates on ETF liquidity and identify interest rate sensitive sectors and compare their liquidity with other sectors. The null hypotheses that we will try to prove are;

H_{1a}: When interest rates increase the liquidity of exchange-traded fund will decrease. This is because at high levels of interest rates it is expensive for market participants to finance their investment holdings as the realised risk increases. The high cost of trading for market participants will further translate to decreasing trading activity. Therefore the market makers will increase the spreads as their cost of liquidity creation goes up.

H_{2a}: The liquidity of ETF sectors that are interest rate sensitive will significantly decrease, from the day following the announcement of interest rate hikes, resulting in the reduced liquidity of those ETFs.

The first section of the study introduces the institutional background of ETFs and the development of the hypothesis. The second part we review the data that will be used and specify the model. The third section is estimating the regression and analyzing the results from the regression and lastly, we draw conclusions of the paper to answer the questions that this paper addresses.

2. Background and Hypothesis Development

2.1 Exchange Traded Funds Background

An exchange-traded fund is a basket of assets whose shares are traded throughout the day in the stock exchange, the price that is used by the investors to trade the basket is the one prevailing in the market. Also, the constituents of the ETF basket are chosen in such a way that

they mimic the components of an index (Antoniewicz & Heinrichs, 2014). The Exchange traded fund have both the characteristics of stocks and mutual funds. Similar to mutual funds, the ETF's basket of securities incorporate various asset classes ranging from stocks, currency, bonds and other asset classes. Furthermore, the differences that ETFs have on mutual funds are; mutual funds are traded at a single price that is the net asset value (NAV) that is calculated at the end of the trading day, whereas ETFs can be traded at any time during the day, and ETFs are recognized as open-end funds, meaning that their shares are continuously offered to the market and if necessary can be purchased back upon request by the sponsor of the ETF (Richards, 2007). Exchange traded funds are comparable to stocks as they are listed on the exchanges, and traded throughout the day at prevailing market price (Richards, 2007).

The first exchanged traded fund Standard & Poor's Depository Receipts (SPDR) also known as spider started trading in the year 1993 January 29 (Richards, 2007). The family of spider ETFs has grown to be the largest ETF globally with assets under management (AUM) totalling $270.74 billion. In 2016 according to Exchange traded funds database (2018), the number of ETFs available globally was 4,779. The use of exchange-traded funds by investors have increased rapidly over the years. According to Kealy, Daly, Melville, Kempeneer, Forstenhauser, Michel, and Kerr (2017), in 2005 the global ETF assets under management (AUM) was $417 billion and in September 2017 the global ETF AUM accounted for $4.4trillion. Furthermore, they assume that in the next three years the ETF industry will have a potential growth totalling the AUM of $7.6 trillion. The amount of assets under management invested in exchange-traded funds captures a large portion of financial markets and therefore have a significant value to the global market. Figure 1; illustrates the AUM of United State exchange-traded funds for the sectors that this paper has sampled, the paper has included All caps equities (this include U.S based ETFs see appendix A) to make the sample larger. In the chart we can deduce that the most popular ETFs that investors trade or hold are technology sector ETFs with $81.196 billion assets followed by financial sector with AUM of $61.518 billion and all the way down to the smallest sector by size; utility has the AUM of $11.595 billion. Amongst the ETFs added in each sector the SPDR ETFs has the largest AUM across all sectors. When summing up the AUMs of SPDR ETFs in the sectors of our sample we can see that its total AUM is $134 719 billion.

The exchange-traded funds are traded in the secondary market, but before the trading takes places in this market there are two significant contributors. The first contributor is the Sponsor of the ETF, the Sponsor can either be a financial institution or company that deals with the

administration and creation of the ETF shares. The second contributor is the Authorized Participant (AP) which is an institution selected by the Sponsor to assembles the assets that will compose the ETF and to create a market for ETF shares (Richards, 2007). The process of assembling these assets is by buying or borrowing the assets from the capital market. When the AP has obtained all the assets, they are deposited to the Sponsor and in return, a creation unit to AP is issued by the Sponsor. The Authorized Participant can hold a block of shares at his own account or break the block of shares to sell to the open market. The investors in the secondary market trade these shares amongst each other. The AP is authorized to create and/ or redeem if necessary the ETF shares with the Sponsor (Antoniewicz & Heinrichs, 2014).

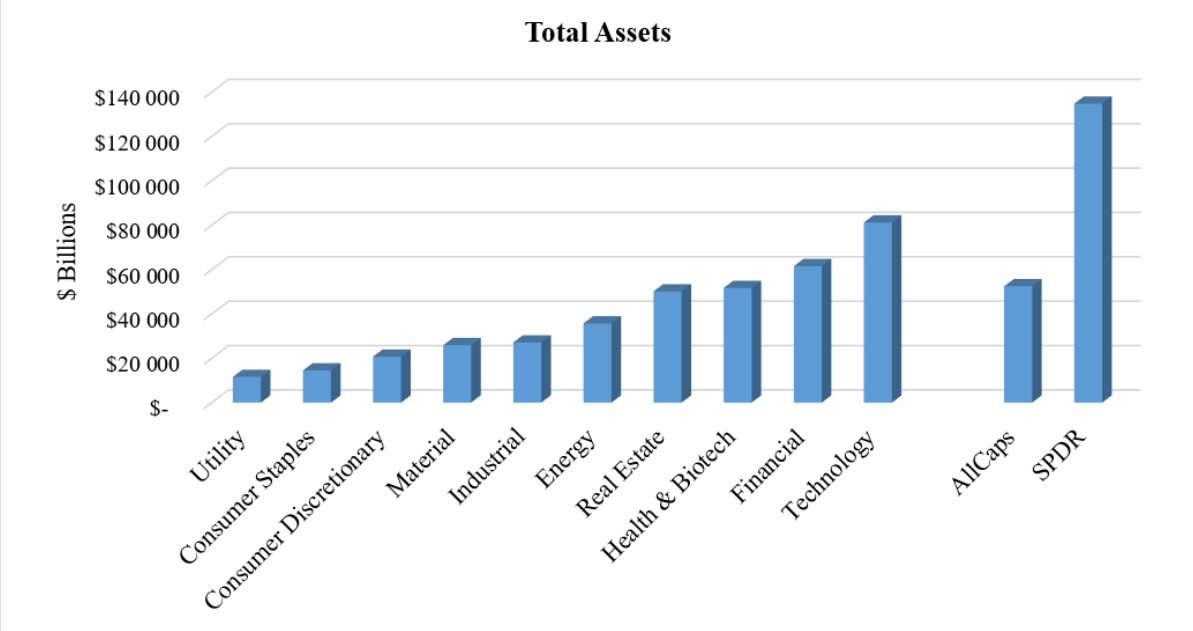

Figure 1[1]: Total assets of exchange-traded funds by sector.

There are some specific features that make ETFs appealing to investors than mutual funds and other index funds. First, expense and fees are one of the factors that reduce investment returns of ETFs and mutual funds, and investors should pay attention to these costs before they invest. According to the United States Security Exchange Commission (2016) ETF's fees are not directly charged from the investors like mutual funds, these expenses and fees are distributed amongst investors of the ETF. This means that as ETFs are passively managed and are liquid investment vehicle the costs associated with the creation of the ETF will be shown by high bid-ask spreads, to investors this would be an indirect cost. It is worth noting that the direct cost

[1] The values used in Figure 1 and 2 are only for United States exchange-traded funds, the values were effective on 28 June 2018 from http://etfdb.com/etfdb-categories/.

that investors have to pay is commission which is the same way as buying stock with their respective brokers, the ETFs costs only becomes higher when an investor trade a small number of shares and also when they frequently trade as the commission will be higher, which in turn offset the low fee benefit factor. Furthermore, ETFs are said to be much cheaper investment vehicles than mutual funds. Richards (2007) compared ETFs' operating costs and that of mutual funds, he found that on average mutual funds that are actively managed charge 1 percent or above, the average costs of index funds were 0.50 percent, and the ETF averaged costs were 0.38 percent a year. Figure 2 Illustrates average expenses of ETFs by sectors and all caps ETFs. Figure 2 shows a range from 0.40 percent to 0.51 percent of fees across all sectors the real estate sector being the cheapest and technology sector is the most expensive sector in the figure. On average the ETF fees illustrated in the figure is 0.47 percent they are close to the 0.38 percent that Richards (2007) have calculated, the difference in values is because there are many ETFs that were created after 2007.

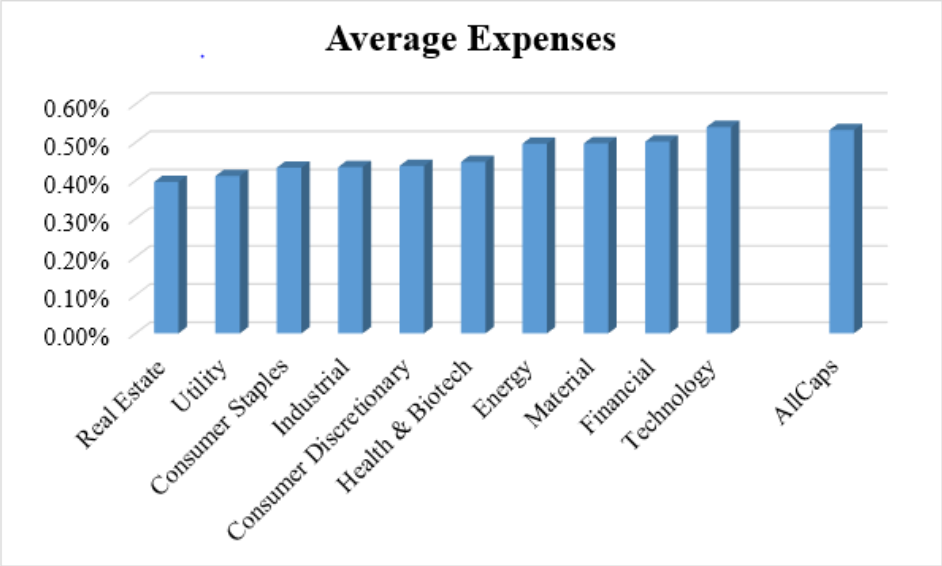

Figure 2: Average Expenses of ETFs by sectors

The second feature that makes ETFs attractive to investors is that they are flexible, as more categories of exchange-traded funds are issued, the investors have increased options such that they can easily access the desired country assets, specific asset classes, style, and investment strategy through ETFs (Carrel & Ferri, 2011). The examples of these categories include the exchange-traded product (ETP) and exchange-traded notes (ETN). The ETP is composed of various financial products classes that aim at providing exposure to financial benchmark, instrument or specific strategy across all asset classes, and ETN is designed as partnerships or trusts that hold tangible precious metals, or hold a derivative contract such as portfolio of

futures, commodity or currency United States Security Exchange Commission (2016). This paper will only look at ETFs as the basket of securities.

The third advantage of exchange-traded funds to mutual funds is that they offer a tax benefit. Based on the different composition of the funds capital gains tax is higher for mutual funds than ETFs, this is because mutual fund's capital gains taxes are imparted to investors over the investment lifespan, whereas ETFs capital gains taxes is subjected when an investor sells the ETF (Justice & Lee, 2012). The dividend tax on ETFs is less valuable as it depends on the types of dividend issues by the ETFs, there is qualified dividend which requires that investors should have held the ETF for a period of 60 days prior to payout date of the dividend. The qualified dividend is taxed subject to investors personal income tax rate which ranges from 5% - 15 % according to Carrel and Ferri, (2011) this number may vary according to countries tax laws. The tax rate for qualified dividend and the unqualified dividend is taxed at the investor's taxable income rate. Furthermore, the exchange-traded notes are constructed in a way that dividend taxation is avoided, the ETNs do not issue a dividend, nevertheless, the ETN price does reflect the dividend value (Justice & Lee, 2012). Last but not least, unlike mutual funds that only trade at the end of the day, ETFs prices are said to be transparent as they can be traded during the day, this means that the prevailing prices incorporate all new information about the ETFs, and thus uninformed investors prefer to trade ETFs due to this benefit (Hamm, 2010).

We have learned about the background of exchange-traded funds, the next section focuses on the main scope of this paper about the liquidity of ETFs, we then look at academic studies on the liquidity of ETFs and interest rates to later formulate our hypothesis.

2.2 Hypothesis development

An asset liquidity is defined by the degree in which an asset can be bought (or sold) at ease and in an appropriate manner, taking into account the costs connected with the transaction of sale (or purchase) or accepting the reasonable price so as to find a seller (or buyer) of the asset at justifiable time (Elliott, 2015). The definition of exchange-traded fund liquidity is similar to the liquidity of an asset defined above, but to understand the ETF liquidity we have to go an extra mile in making a distinction between the determinants of the primary and the secondary market liquidity of an ETF. This is because primary market liquidity also affects the secondary market liquidity. In the previous section of the study we have indicated significant participants in the creation of the ETF which were; the sponsor and authorized participants (AP), these two

players are involved in the primary market, and the secondary market players are individual investors and institutional investors as well.

According to Crigger (2018) the investors that place large trade orders in quantities of tens of thousands of share in a case where an investor trades an amount close to 50 000 shares or more, on occasion these investors are able to bypass an illiquid secondary market of ETF by making use of the AP to influence the primary market and generate new ETF shares. When this occurs the liquidity that is relevant to this transaction is the liquidity of the underlying securities of the ETF. This means that for the AP to create 50 000 shares a pre-specified basket of the underlying securities (creation basket) must be submitted to the ETF, before the submission of these shares to the ETF the AP needs to trade in the underlying securities market and if the AP is able to access easily the underlying securities market, he or she can create and redeem ETF shares more efficiently (Crigger, 2018). This means that there is a direct connection between the primary market liquidity and the underlying assets liquidity. The investors that trade in the secondary market trade small quantities that are way below the 50 000 shares in our example and they trade amongst each other or the market makers for the supply of the existing ETFs shares, and the liquidity for this market is live on from the brokerage screen and it is primarily determined by the volume of traded ETF shares (Crigger, 2018). Investors in this market assess liquidity by paying attention into statistics that correspond to averages of; spreads, trading volume, discounts and premiums and the price impact i.e. if the trade closes at net asset value (NAV) of the ETF.

Early studies, Kyle (1985), define market liquidity as three components of transaction costs, the first is depth which examines the capability of the market to take in large transactions without having a great consequence on prices. The second is the tightness of the market which indicates the expense incurred for trading a position at a short period of time. The third is resiliency of the market that examines how rapid prices move towards their fundamental values. Moreover, Kyle (1985) established the method of identifying how informed traders profit from private information about the value of assets and taking advantage of uninformed traders. Later Subrahmanyam (1991) extended Kyles model, due to private information he introduced the trading of the basket of stocks for which he explained that information differences to traders will be minimized as uninformed traders prefer a basket of assets than competing with informed traders on individual assets. Hamm (2010) studied the influence of introducing ETFs on the liquidity of underlying assets, the study validates the Kyle (1985) and Subrahmanyam (1991) studies. Hamm (2010) Found that the basket of securities is most likely

to be traded and preferred by uninformed traders, the study explains that this preference is driven by the cost of adverse selection on individual stocks. Hamm (2010) found evidence that explains that ETFs stand to gain liquidity from trading in the underlying securities market. Marshall, Nguyen, and Visaltanachoti (2015) and Calamia, Deville, and Riva (2015) studied causal effect between the ETFs liquidity and underlying securities liquidity and they found the same results as Hamm (2010) that liquidity of the underlying assets influences the liquidity of ETFs but reverse effect is much weaker for the ETF liquidity to influence the liquidity of its underlying securities.

Oppenheimer Funds (2016) does not agree with Crigger (2018) with the idea ETFs liquidity is primarily determined by trading volume. The Oppenheimer Funds (2016) argues that the average daily trading volume can be a good indicator for the liquidity of stocks but this notion does not extend to liquidity of ETFs, this is because stock shares are limited whereas ETFs are not due to the fact that they are continuously created and redeemed when necessary or at shareholders request. Vanguard (2015) further supports the argument that in a case where there is excess supply (demand/ supply imbalances) the Authorized Participant repurchases the ETF shares from investors in the secondary market, the redemption process is the reverse transaction from the creation process as discussed previously. The redemption of shares will decrease supply until equilibrium. In essence, trading volume becomes an insignificant indicator for the overall ETF liquidity since APs have the authority to redeem the shares at any point necessary (Vanguard, 2015).

The market is said to be liquid when the bid/ ask spreads of assets are smaller and prices do not deviate from their fundamental value when placing large volume trades. According to Oppenheimer Funds (2016) the spreads depend on the ETF market maker's ability and willingness to create the market for these funds. Also, there are other elements that can impact the bid/ask spread of ETF. The first is the secondary market trading volume, the more trades occurring the spreads will decline. The second is hedging investment exposure costs, the market makers sometimes retain buy or sell positions of the ETF they are creating the market for, to reduce the risk they either buy or sell the assets underlying the ETF or often use derivatives to hedge their positions. However if the market makers hedged position mistrack the ETF or they are unable to buy the underlying assets on time, they respond by setting wider bid-ask spreads of the ETF to take care of the risk they undertake in the trade to provide liquidity (Thomas, 2017). Lastly, the creation and redemption costs of ETF shares, in an instance where trading volume is low in the secondary market, for the AP to create the position

that is required might take a while, during the period they also have to hedge against market risk therefore when the process of acquiring positions is reached all the cost incurred from hedging are passed down to investors and will be reflected on the high bid-ask spread (Richards, 2007). Furthermore, as the ETF market matures intervention to maintain liquidity becomes minimal for APs and/or market makers, since the bid-ask spreads decrease significantly as the ETF trade closer to its fundamental value. This means that when ETFs spreads are low or the bid and ask prices are close or equal for an extended period there is no need for the AP to influence the liquidity of ETFs i.e. by buying or selling ETFs shares. Therefore the cost of creating new ETF shares or redeeming shares that were incurred before have will go down or be eliminated and ETFs investors will no longer be charged on these costs for creating liquidity.

One of the key structures of exchange-traded funds is to replicate the market index they track based on strategy, style, sector indices and so forth, therefore it should be of investors' interest to learn if there is any correlation between the liquidity of exchange-traded fund and its underlying index liquidity. Chordia, Roll, and Subrahmanyam (2000) studied the effects of commonality in liquidity in the market and they found that volatility, volume and price have a significant impact of liquidity, the results also suggested that inventory risk and asymmetric information jointly influence liquidity changes in the market. Calamia, Deville, and Riva (2014) studied the determinants of ETF liquidity in response to the liquidity of the market indices the ETFs track, their argument was based on inventory risk management. They explained that if the market maker or AP has a short position at the end of the trading day, he will instructs the sponsor to create a unit of ETF shares, the process of creating new shares will occur as we have explained previously and the AP will purchase the underlying stock in the secondary market, if the stocks are illiquid the AP will bear the cost of individual stock liquidity. Henceforth, they predicted that an ETF that mimic a market index that is illiquid will trade with wider spreads and there is a positive correlation between ETF spreads and its underlying index. Calamia et al. (2014) found their results to be consistent with their prediction that there is a positive relationship between the ETF spreads and inventory risk. This means that ETFs spreads are expected to increase when the underlying index volatility rise.

Fernández-Amador, Gächter, Larch and Peter (2011) studied the effect of monetary policy on stock market liquidity, their argument was based on inventory model which suggest that equity markets are predicted to be liquid since it is less expensive for the market participants to finance their holdings and at low risk. In a case of a change in policy regime, this change affects the

recognized risk and financing cost of holding the asset (for example through the general economic channel for policy influence), therefore we can deduce that monetary policy can also affect stock market liquidity (Fernández-Amador et al. 2011). In essence, when the Fed implements contractionary monetary policy this regime creates high financing cost and this creates uncertainty in the market increasing market volatility and when market volatility increases this has an adverse effect on liquidity of ETFs.

Marshall et al. (2015) studied the liquidity in periodic patterns of exchange-traded funds on different days of the week paying attention to bid-ask spreads, they found that intraday patterns in liquidity show spread to be higher on Monday than Wednesday and Thursday, also they found no indication of Fridays to have lower spreads for US equities and equity sector ETFs. Furthermore, they also found that the bid-ask spreads are far apart following a period of no trade, they suggest that this is because of adverse selection cost. The days of no trade they referred to were weekends and public holidays. Chordia, Roll, and Subrahmanyam (2001) studies the liquidity patterns of the market on different days of the week and over public holidays, they also found consistent results as Marshall et al. (2015) that Friday tends to have lower liquidity and also Tuesday's liquidity increases with increasing trading activity. Moreover, Chordia et al. (2001) made further contribution and predicted that changes in liquidity might arise due to information events in the market these informational events were based on macroeconomic announcements the variables were; gross domestic product (GDP), unemployment, and Consumer price index (CPI) announcement days and they found an increase in trading activity and market depth prior to the two days of GDP and unemployment announcement and then trading activity goes back to the regular levels on the day of the announcement. Taking further the announcement effect of microeconomic variables to financial markets, Bernanke and Kuttner (2004) and Benerjee and Seccia (2001) studied the Hirshleifer effect of unscheduled monetary policy announcements in interest rate futures they explained that market participants for (example Authorized Participants of ETF) that are holding hedging assets cluster their volumes of trade around the predicted dates of the announcement because there is a high level of certainty and transparency. The Hirshleifer effect advocates that there is a negative influence of interest rates when information is announced quicker (publish information before trades occur) than anticipated, this affects the risk sharing of market participants (Hirshleifer, 1971). This effect produces a lot of noise trading. When the announcement occurs at unscheduled dates it often surprises the financial market and this creates a high level of uncertainty and market participants arbitrage their income by transferring

it from an uncertain state to the realised state. This means that unanticipated publication of macroeconomic variable (for example Fed fund rate) announcement might have a negative effect on the traded volume of assets (Hirshleifer, 1971). The findings of Benerjee and Seccia (2001) were consistent with Chordia et al. (2001) when the announcements are made in scheduled date trading activity is higher prior to the date of announcement but when the announcement date is unscheduled the trade appeared to be lower than anticipated due to the inability of traders to hedge their positions against interest rate change. For ETFs what this means is that if the hedge position of the AP has gone wrong due to this unexpected event they will respond by setting the bid-ask spreads to be higher.

Interest rates play a crucial role in the financial market. Any change in interest rate changes the value of assets or portfolios. Ali (2014) found that interest rates have a negative impact on the stock market. Malik (2015) and Garg (2008) finds that the response of equity market to interest rates differs according to interest rate sensitive sectors such as Financial, Utilities, and Real Estate tend to underperform following first interest rate hike and sectors such as industrials outperform during this period. This paper anticipates the reaction to be the same with exchange-traded fund due to similar characteristics with stocks. Chordia et al. (2001) investigated how changes in interest rates affect daily fluctuations in liquidity and trading activity in the market, they argued that due to market frictions from short-selling constraints and margin requirements indicates that interest rate is also a determinant of liquidity. This means that when interest rates are increasing the cost of trading margin account by market participants will be increased, this increase will discourage trading activity leading to a decline in market liquidity. For ETFs when markets are illiquid the creation process of ETF shares becomes slower and the cost the AP incurred in the process of creating shares will be passed downs to investors as reflected by high bid and ask prices. Therefore, Chordia et al. (2001) found evidence that a rise in short or long-term interest rates has a negative effect on liquidity and trading activity in the market, and this relationship is significant.

Based on this evidence about the liquidity of ETFs and interest rate this study will adopt a few suggestions made by previous studies. The study will embraces Calamia et al. (2014) which predicted that ETFs that mimic indices that are illiquid, trade with wider spreads. We also adopt Nemes (2012) who predicted that volatility of ETFs is normally smaller than that of the individual assets, this is because ETFs exposure to idiosyncratic risk is smaller. We also adopt Bernanke and Kuttner (2004) and Benerjee and Seccia (2001) study about the Hirshleifer effect

of unscheduled monetary policy announcements in interest rate futures, with the idea that when the announcements are made in scheduled date trading activity is higher prior to the date of the announcement, in this paper we assume that the announcement dates of the federal fund rate are known in advance by market markers. Moreover, the study adopts Chordia et al. (2001) predictions that there is a negative relationship between interest rates (short term and long term) on the liquidity of the market. This paper will observe this prediction with regards to ETFs liquidity. Lastly, the study will take on Malik (2015) and Garg (2008) predictions that the response of equity market to interest rates differs, according to interest rate sensitive sectors such as Financial, Utilities, and Real Estate tend to underperform following first interest rate hike and sectors such as industrials outperform during this period.

The following questions will be addressed in order to come to the conclusion of the paper:

- What are the measures the study will apply in identifying the factors that affect the liquidity of ETFs?
- What is the response of ETFs' liquidity when interest rates are added as the liquidity factor of ETF? Is the reaction similar towards different interest rates i.e. long-term and short-term interest rates?
- To what extent is the liquidity of interest rate sensitive sectors affected by the interest rate changes compared with other sectors?

The objectives of the study are outlined as follows:

- Identify liquidity measures of ETFs
- Estimate the effect of interest rates on ETF liquidity
- Identify interest rate sensitive sectors and compare their liquidity with other sectors

2.3 Hypothesis

H_{1a}: When interest rates increase the liquidity of exchange-traded fund will decrease. This is because at high levels of interest rates it is expensive for market participants to finance their investment holdings as the realised risk increases. The high cost of trading for market participants will further translate to decreasing trading activity. Therefore the market makers will increase the spreads as their cost of liquidity creation goes up.

H_{2a}: The liquidity of ETFs sectors that are interest rate sensitive will significantly decrease, from the days following the announcement of interest rate hikes, resulting in the reduced liquidity of those ETFs.

3. Data description and variables measures

3.1 Data description

To answer the questions of this paper daily data for the period of 12 years and 6months will be used starting from 01/01/2006 to 29/06/2018. The sample of exchange-traded funds that will be used originates in the United States and the ETFs sample is comprised of; 5 ETFs of utilities sector, 9 ETFs of technology sector, 7 ETFs of financial sector, 5 ETFs of consumer discretionary sector, 4 ETFs of consumer staple sector, 6 ETFs of energy sector, 6 ETFs of health and biotechnology sector, 4 ETFs of industrial sector, 3 ETFs of material sector, 4 ETFs of real estate sector and we added 8 all caps for diversified ETFs to create a larger sample. The Allcaps ETFs are funds with underlying assets that invest across all market capitalisation i.e. small, medium and large caps and this includes investing across all sectors of equity stocks. The data sample has excluded the ETFs that are used for hedging other currencies, and global ETFs trading in the US, This is because the underlying securities of these ETFs are denominated in other currencies. Also, for other sectors such as telecommunication, transport and so on, are excluded because they do not have the required data for the period observed in the study. This leaves an overall sample of 60 ETFs in total (see Appendix A for the list). To obtain liquidity values we will collect returns, volume, and closing bid and ask prices and closing prices for each exchange-traded fund. With the closing prices, we have removed the days where prices were not available, on average the number of days without prices are seven days and they are not concentrated on a single period, they differ across the observed period for each ETF. For the explanatory variables we collected data on interest rates; Federal fund rate, 10 years constant maturity bond rate and Baa Moody's corporate bond rate, also obtained the federal reserve bank policy announcements dates, and lastly we obtain data of VIX index as a proxy for market volatility which we use the standard deviation of returns.

The data used in the study is obtained from Exchange Traded funds database[2] the initial sample had 340 equity ETFs from the eleven sectors mentioned above. The ETFs that were created after the 1st January 2006 were removed from the sample as they do not fit within the sample period of the study, thus we were left with 60 ETFs in our sample. The data for liquidity

[2] Exchange-traded funds database: http://etfdb.com/etfdb-categories/.

determinants as stated above is obtained from the Center for Research in Security Prices (CRSP) database. The data for treasury securities and announcement dates we obtained from United State Federal Reserve Bank[3]. The data for Baa Moody's corporate bond rate is obtained from DataStream. Data on VIX is obtained from the Chicago Board Options Exchange (CBO)[4].

3.2 Variable measures

For all exchanges traded funds in our sample the following dependent variables are the proxy variables that are used as measures of liquidity and they are; quoted spread, effective spread, Amihud illiquidity measure and volume. These variables are explained below. The quoted spread is computed as shown in equation 1:

$$Quoted\ Spread = \frac{A_k - B_k}{M_k} \quad (1)$$

Where "A_k", "B_k", and "M_k" are closing ask price, closing bid price and the midpoint of the two prices of ETFs respectively. The average quoted spread for daily sector spreads are computed by averaging all individual ETFs of that respective sector (Fong, Holden, & Trzcinka, 2017).

The effective spread is computed as shown in equation 2:

$$Effective\ Spread = 2 \mid ln(P_k) - ln(M_k) \mid \quad (2)$$

Following Fong et al. (2017), where "P_k" denoted the closing price of the trading day, and "M_k" is the midpoint of closing bid and ask price that is consolidated at the end of the trading day. The average daily sector effective spread is computed by averaging all individual ETFs of that respective sector. The absolute values are used as the final value of the effective spread.

Amihud illiquidity measure is computed below:

$$A_{id} = \frac{|r_{id}|}{Dvol_{id}} \quad (3)$$

Where "A_{id}" is the Amihud illiquidity measure of ETF *i* value on a day *d*; "r_{id}" and "$Dvol_{id}$" measures the daily absolute returns and daily dollar trading volume of ETF *i* on day *d* (Lou & Shu, 2014). The Amihud value is then multiplied by one million to accommodate the large

[3] United States Federal Reserve Bank: https://www.federalreserve.gov/releases/h15/data.htm
[4] Chicago Board Options Exchange (CBO: http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/vix-historical-data

differences between volume and returns. The average daily sector Amihud liquidity proxy is computed by averaging all individual ETFs of that respective sector.

Share volume: is the total number of shares traded daily, the average daily sector share volume is computed by averaging all individual ETF's share volume of that respective sector.

Dollar Volume: is the number of outstanding shares multiplied by the share price on that specific trading day, the average daily sector dollar volume is computed by averaging all individual ETF's dollar volume of that respective sector. This measures the trading activity of ETFs.

3.3 Model specification

The specified model below was inspired by Chordia et al. (2001) and some variables from the original model were omitted to suit the research question of this paper. The model suggests that the liquidity of exchange-traded funds can be explained by short term interest rates, term spread, quality spread, volatility index and the macroeconomic announcements of federal fund rate. The model is as follows:

$$\boldsymbol{Liquidity_t = \alpha_t + \beta_1 ShortRate_t + \beta_2 TermSpread_t + \beta_3 QualitySpread_t + \beta_4 VIX_t + \beta_5 RI(0)_t + \beta_6 RI(1-2)_t + \varepsilon_t}$$

***Liquidity*:** is the dependent variable, its proxies are daily average; quoted spread, effective spread, Amihud illiquidity measure (all these measures the transaction costs) and last is the volume which measures the trading activity. The variables are explained above.

3.3.1 Explanatory variables definition and apriori expectation

***Short rate*:** is the daily United States Federal Fund rate.

***Term spread*:** is the difference between the constant maturity 10 year Treasury bond yield and the federal fund rate and is measured daily.

Quality spread: the daily quality spread is measured by taking the difference between Moody's Baa corporate bond yield and the 10-year constant maturity Treasury bond yield.

***Volatility Index (VIX)*:** is the daily standard deviation of market returns.

RI (0): is the dummy variable for the day of federal fund rate announcement date, it takes the value of 1 on the day of announcement and 0 otherwise.

R1 (1-2): is the dummy variable of the two days before of federal fund rate announcement date, it takes the value of 1 on the two days prior to announcement date and 0 otherwise.

We expect a negative relationship between ETF liquidity and the short-term interest rate, term spread, quality spread, volatility index and the two days before the federal fund rate announcement date. Also, the relationship is expected to be positive or neutral for the federal fund rate announcement.Since then there is no direct measure of liquidity but the proxies, the expected relationship will differ. Therefore, we expect relationship of liquidity spreads and short interest rate, term spread, quality spread, volatility index and the two days before the federal fund rate announcement date to be positive, and the relationship is expected to be negative or neutral for the federal fund rate announcement day according to (Chordia et al. 2001) and (Benerjee & Seccia 2001). The intuition is that when interest rates increase the spreads will increase and thus leading to declining liquidity since the spreads are moving far apart as the cost of rebalancing the portfolio increase to accommodate the interest rate changes. The dollar volume measures trading activity, and we expect positive relationship in trading activity and with the dummy variable of the two days prior to the announcement dates and negative with the dummy variable on the day of the announcement.

We expect a positive relationship between Amihud illiquidity and interest rates. Moreover when trading volume is high Amihud illiquidity will fall. Lou and Shu (2014) suggest that the linkage between trading volume and Amihud is stronger since the variation in trading volume is greater than that of the return of stock i.e. in this case ETF returns.

4. Regression results

In this section, we report the estimated results and analysis of the model specified above. The tables, figures and regressions are constructed and/or estimated using Eviews 10 software. The results and analysis are shown below.

Table1 illustrates a summary of descriptive statistics of the proxies that measure liquidity and trading activity of exchange-traded funds. We can deduce that all variables have some degree of variability, with the coefficient of variation for average percent quoted spread, effective spread and Amihud illiquidity is higher than trading activity. The effective spreads are higher than quoted spreads, this means that investors are getting less than the bid price or paying more than the ask price. The average dollar volume and share volume do not vary as much. The mean and the median for individual variables are closer to each other, which means they are almost symmetric and there is no significant skewness, except for the Amihud illiquidity the mean and

median are slightly far apart. Figure 3 and figure 4 are the presentations of the ETF liquidity proxies' average quoted and effective spreads expressed in dollars and percentages, the values that are used are transformed from daily to monthly data. Both graphical presentations of figure 3 and 4 exhibit a similar trend, the graphs are consistent to table 1 descriptive statistics that effective spreads are higher than quoted spreads. The exchange-traded funds had high spreads in late 2008 following the 2007/ 08 global financial crisis, the monthly average spreads were as high as 0.76% for the percent quoted spread and 0.85% for percent effective spread this was during the month of September 2008 and 0.44% and 0.88% respectively for the month of October 2008.

Furthermore, during the period May 2010, the realized effective spreads were higher during this period it was due to the flash crash. The flash crash was due to an instant decrease in the U.S. equity market, this resulted into liquidity providers of ETFs to have difficulty valuing the ETFs underlying securities, many trades in exchanges were cancelled with the fear of incurring high risks, the market makers pulled back on bidding for shares on many ETFs (Blackrock, 2011). Moreover, in 2015 the effective spreads had a large increase this was during the period where there was a delay of the stock price as New York Stock Exchange opened several minutes later than other parts of the market, this meant that it was impossible to value many ETFs and stocks at the same price. This resulted in a lack of liquidity since there were many sellers but not enough buyers (Pisani, 2015).

Also, later in 2015, the Federal Reserve Bank initiated the first increase of the federal fund rate following the decline of interest rates since the financial crisis in 2007/08. Lastly, in 2018 the graphs illustrate high effective spreads this followed after a drop of S&P 500 index leading to three most volatile days. According to Tierney and Johnson (2018) the ETFs bid and ask spreads increased by 0.06% but not as much as the increase of 0.15% of the underlying assets of the ETFs during the three days of high volatility. Overall the effective spreads are not as stable as quoted spreads, it is worth noting that in general ETFs spreads are very low and close to zero. We can also deduce that effective spreads are higher than quoted spreads, this might be due to some that orders are executed outside the quoted spread because they are large orders hence we have quoted spreads smaller than effective spreads (Subhrendu, 2004)

Figure 5 show the trading activity of ETFs during the observed periods of this paper, we can see that the dollar volume has been increasing since 2006 with a slight drop during the financial crisis in 2008 and also during 2015 the trend is consistent to the effective spread. We can see

that when trading volume decreases the spreads are increasing i.e. especially effective spreads. The number of ETF shares traded tends to increase with increasing spreads during the period of market distress. Overall the trend of ETF shares traded relative to the dollar volume of trade is declining.

Table 1: Average exchange-traded funds liquidity variables,

The table displays descriptive statistics for time series data of ETFs liquidity measures. The liquidity variables of individual ETFs are constructed as per equation 1 quoted spread, equation 2 effective spread, equation 3 Amihud illiquidity proxy, share volume is the number of shares traded daily, dollar volume is the number of shares outstanding multiplied by share price and the price is the daily prevailing closing price of the ETF. The share volume and dollar volume are logged. The individual ETF quoted spread, effective spread, Amihud illiquidity, Share volume, dollar volume and price are then averaged according to their respective sector and we further obtain sector averages as per liquidity measure. The acronym Quoted spread $, %Quoted Spread, Effective Spread$, and % Effective Spread, Amihud, Share Volume, Dollar Volume and price represent the average liquidity of 11 sectors. The samples period is from 03 January 2006 to 29 June 2018.

	$ Quoted Spread	$ Effective Spread	% Quoted Spread	% Effective Spread	Amihud	$ Volume ($million)	Share Volume (million)	Price
Mean	0.041	0.064	0.095	0.151	5.065	14.442	14.747	61.002
Median	0.030	0.049	0.064	0.099	3.030	14.402	14.784	57.898
Maximum	0.576	1.132	1.806	4.656	87.830	15.480	16.686	95.379
Minimum	0.016	0.021	0.033	0.042	0.482	13.255	12.107	24.192
Standard deviation	0.030	0.059	0.097	0.248	6.890	0.659	0.551	16.769
Coefficient of variation	0.746	0.908	1.016	1.642	1.360	0.046	0.037	0.275
Number of Observations	3145		Number of Sectors	11		Number of ETFs	60	

Table 4 in Appendix B shows the correlation matrix of the liquidity measures and their level of significance. For all correlations of variables, we can observe that they are all statistically significant at one percent level of significance. The dollar volume and price are negatively correlated to Quoted spread $, %Quoted Spread, Effective Spread$, and % Effective Spread, Amihud, Price is also negatively correlated to Share Volume and the rest of the variables are positively correlated to each other. The $Quoted spread and %Quoted Spread, $Effective Spread and %Effective Spread, $Volume and price, $Quoted spread and $Effective Spread, %Quoted Spread and Amihud are strongly correlated to each other. The correlation is weak with Share Volume versus the percent/dollar Effective Spreads and $Volume, also it is weak on Price versus percent/dollar Effective Spreads.

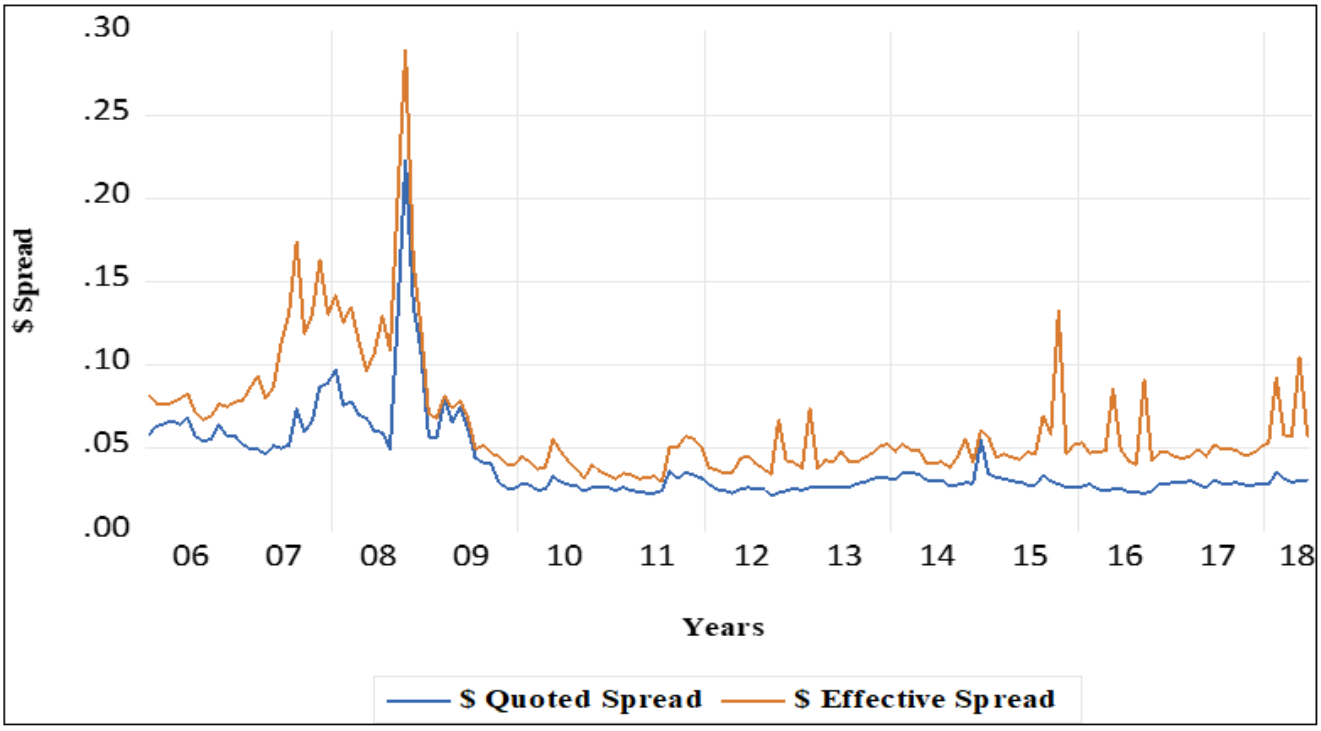

Figure 3: Monthly average dollar quoted spread and effective spread.

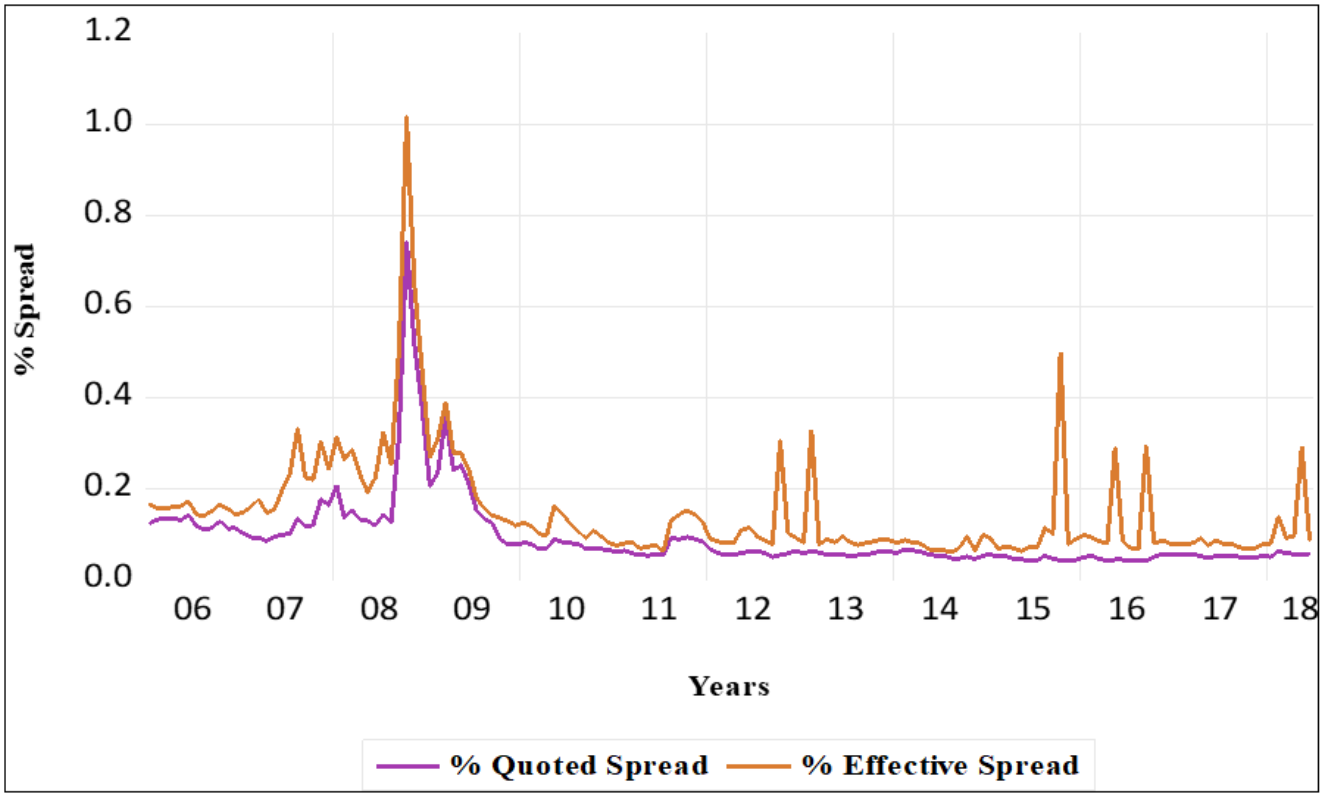

Figure 4: Monthly average percent quoted spread and effective spread

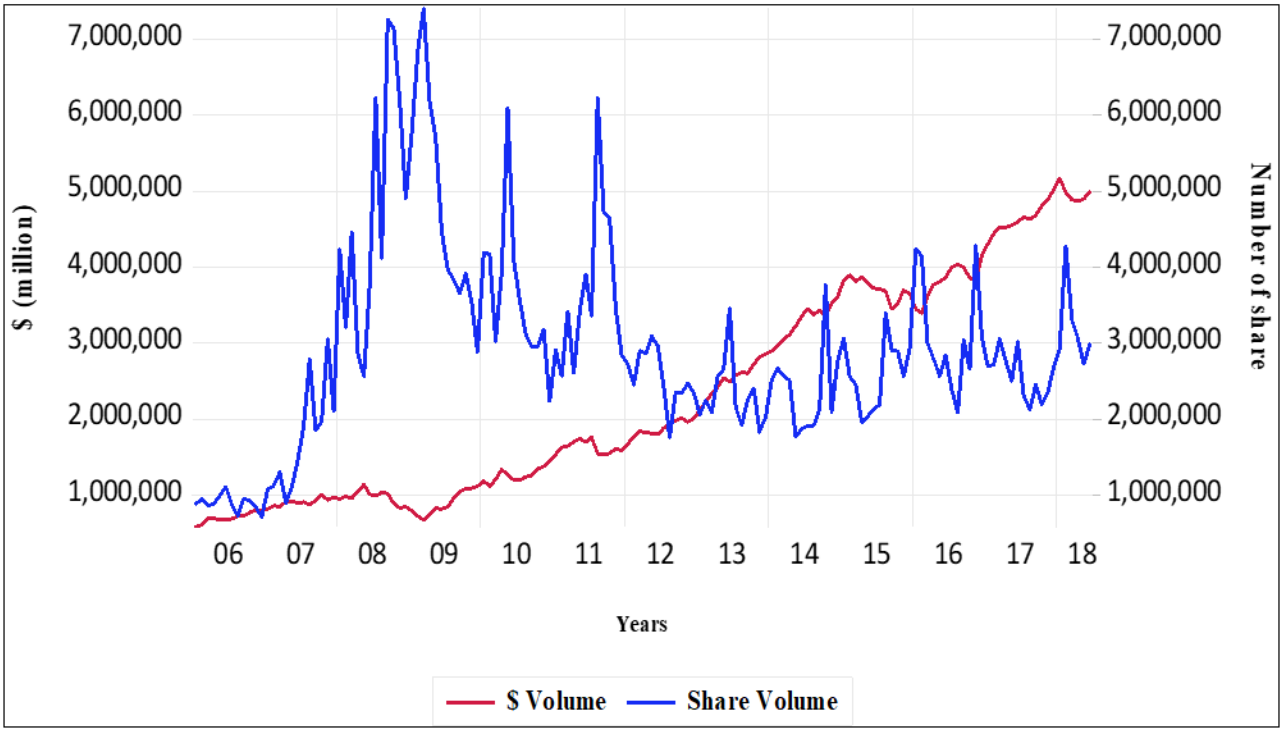

Figure 5: Monthly average $ Volume and Share Volume.

Table 2 also expresses the correlation between the dependent variables and independent variables. The Short Rate has a negative correlation with Amihud, $ Volume, Term Spread, Quality Spread Volatility index (VIX) and the federal fund rate announcements dummies RI (0) and RI (1-2) variables. The %Effective Spread is negatively correlated with Term spread. The dummy variable RI (1-2) is negatively correlated with %Effective Spread, Amihud and RI (0). The $ Volume is negatives correlated with Quality Spread and VIX. The other variables are positively correlated with each other. The correlation is mostly weak with the dummies variables RI (0) and RI (1-2) versus all the other variables. There is also a weak correlation between VIX versus Short Rate, $Volume versus Quality Spread and Term spread, moreover, Short Rate and Term Spread versus % Quoted, % Effective Spread and Amihud. The correlation is stronger with VIX versus % Quoted, Amihud and Quality Spread, also on Term spread versus Short Rate. The correlation of RI (1-2) versus all the dependent variables, RI (0) versus Quality Spread and dependent variables excluding Amihud their correlation is not significant, also Short Rate versus Amihud the correlation is not significant. All other variables have a significant correlation with each other.

The figures in Appendix C illustrate the average liquidity measures of the three ETF sectors that are sensitive to interest rates, namely Utility, Real Estate and Financial sectors, we also

included the Allcaps averages so as to make some valid comparison. The Allcaps includes all the equity stocks from different sectors, small to large market capitalization. On average the liquidity of real estate sector tend to be stable and it is closer to zero for all the liquidity proxies percent quoted spread, percent effective spread and Amihud illiquidity. The only time the spreads for real estate were seen to be higher was during the financial crisis in 2008. The utility sector on average tend to deviate across the sample period, the declining liquidity due to market frictions as explained previously is more pronounced when using Amihud liquidity measure also for Financial sector. In comparison to the Allcaps, on average the Allcaps tend to exhibit higher spreads, therefore, we would expect low liquidity for Allcaps. Trading activity (dollar volume) is higher for Real estate than other sectors, this is due to high liquidity in this sector i.e. the average spreads are stable and closer to zero. Trading activity for utility is very low this could also be due to lower liquidity as expressed in the data, utility tends to be volatile. Trading activity of the financial sector and Allcaps is increasing with time.

Table 5 in Appendix D show the regression results for daily averages of ETFs sectors; utility, financial, real estate, technology, consumer discretionary, consumer staples, energy, health and biotech, industrial, material, and Allcap. The results for these sectors are expressed by their liquidity proxies, panel A regresses the daily percentage quoted spreads and panel B percentage effective spreads, panel C Amihud liquidity measure and panel D dollar volume. The other dependent variables are not expressed in the model because they exhibit similar trends and therefore would yield similar results. The explanatory variables are the short rate, term spreads, quality spread, volatility index (VIX) and the dummies variables for federal fund rate announcement dates. The Ordinary Least Square OLS regressions are estimated using Newey west standard errors and the number of lags are reported. The number of observations included in the models is 3,145. The results are analysed below;

The R squared measures the percentage that the explanatory variables explain the dependent variable. In appendix D table 5 reports the R squared for each dependent variables and the results are as follow; panel A %Quoted spreads have R-squared between 0.3989 to 0.6654, for panel B %Effective spread is between 0.0026 to 0.5380, for panel C Amihud it is between 0.2109 to 0.5232 and panel D $Volume it is between 0.6290 to 0.8930. When R squared is higher it means that the explanatory variable explains more of the dependent variable. In our regressions, the explanatory variables seem to explain more of $volume than other dependent variables.

Table 2: Correlation matrix of exchange-traded funds liquidity variables and explanatory variables

The results show the correlation of daily average measures of liquidity variables. The acronyms % Quoted and % Effective Spread, Amihud and Dollar Volume represent the daily average ETF liquidity of 11 sectors. The dollar volume is logged. Furthermore, the table demonstrates the correlation between the explanatory variables. The acronyms short rate, term spread, quality spread, VIX (volatility index), and dummy variables RI (0) as the day of the policy announcement and RI (1-2) are the two days prior to policy announcement day. The correlation of dependent variables (liquidity measures) and explanatory variable can be observed. From the table, we can also observe the significance levels of correlation.

Correlation Probability	% Quoted Spread	% Effective Spread	Amihud	SVolume ($million)	Short Rate	Term Spread	Quality Spread	VIX	RI (0)	RI (1-2)
% Quoted Spread	**1**									

% Effective Spread	0.4614	**1**								
	0.0000	---								
Amihud	0.6969	0.3401	**1**							
	0.0000	0.0000	---							
SVolume ($million)	-0.4921	-0.2226	-0.3942	**1**						
	0.0000	0.0000	0.0000	---						
Short Rate	0.164	0.102	-0.008	-0.532	**1**					
	0.000	0.000	0.646	0.000	---					
Term Spread	0.030	-0.030	0.136	0.172	-0.848	**1**				
	0.088	0.097	0.000	0.000	0.000	---				
Quality Spread	0.508	0.246	0.583	-0.199	-0.520	0.517	**1**			
	0.000	0.000	0.000	0.000	0.000	0.000	---			
VIX	0.716	0.355	0.723	-0.436	-0.174	0.321	0.778	**1**		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	---		
RI (0)	0.023	0.013	0.030	0.019	-0.036	0.030	0.026	0.016	**1**	
	0.198	0.460	0.098	0.288	0.044	0.088	0.138	0.370	---	
RI (1-2)	0.008	-0.008	-0.005	0.025	-0.047	0.039	0.035	0.036	-0.036	**1**
	0.661	0.654	0.781	0.157	0.008	0.028	0.052	0.044	0.045	---

The Durbin Watson assess the residual if they exhibit autocorrelation if the Durbin Watson is between 2 and 4 it means that we accept the null hypothesis that there is no autocorrelation. The Durbin Watson results are present in table 3 and they are; panel A %Quoted spreads have Durbin Watson between 0.7043 to 1.4011, for panel B %Effective spread is between 1.1127 to2.0809, for panel C Amihud illiquidity is between 1.5396 to 1.9768 and panel D $Volume it is between 0.0062 to 0.0633. From the regressions, we reject the null hypothesis and confirm that there is positive autocorrelation in residuals.

The short rate measures the cost that Authorised participants would incur from short selling given an increase in interest rates. The relationship between the short rate and the dependent variable; %Quoted spreads, %Effective spreads, Amihud illiquidity is positive for the most sector. However, it is negative for %Effective spread (Allcaps) and Amihud (technology, energy and Allcaps). The short rate has a negative relationship with $volume. The short rate is significant in all dependent various excluding technology and Allcaps. The coefficients are small for spreads, on average when short rate increases by one percent, the %Quoted spread increase by 0.0318% and %Effective spreads increase by 0.0413%. This means that the liquidity of ETFs will decline by the stated values of the spreads. The average decline in liquidity estimated by Amihud illiquidity measure is 1.7898. Also, the average $volume decreases by $583 792 with increasing interest rates. This is consistent with our expectations as the liquidity declines trading also decreases.

The term spread on average have a positive relationship with the liquidity variables, and negative with $ volume. The term spreads is significant at different levels of significance one percent, five percent, and ten percent across all dependent variables, however sectors such as energy, utility, fin, industrial and Allcaps are not significant. Please note that the sectors are not all insignificant to all dependent variables. We can deduce that when term spread is increasing the spreads and Amihud illiquidity are increasing but the effect is lower than the increase in short rate. The average %Quoted spread increases by 0.0174%, %Effective spreads by 0.0039% and Amihud illiquidity by 0.4061. The same occurs for $ volume decreases by $485 810. This means that the liquidity is decreasing but at an increasing rate vice versa with trading activity.

The average relationship between quality spread and liquidity measures is positive and negative for trading activity. This relationship is significant at different levels of significance, but there are sector variables that are not significant. Unlike with the term spread, when quality spread increases the liquidity of ETFs falls by a larger amount than increasing short rates, i.e. %Quoted

spreads increase by 0.0379%, %Effective spreads increase by 0.0432% and Amihud illiquidity goes up by 4.1196. However, trading activity continues to fall ($Volume by $ 473 701).
The volatility index VIX has a positive relationship with all dependent variables i.e. liquidity variable and trading activity. However the relationship is negative for Allcaps with the %Effective spread, and on $ Volume it is negative with real estate, consumer discretionary and health and biotech. On average the liquidity measures are significant, and trading activity is not significant. When the market volatility increases by one percent, the average %Quoted spread increase by 0.0053%, the %Effective spread increase by 0.0084% and Amihud illiquidity increases by 0.3930. The explanation of the low increase in spreads unlike stocks might be due to the fact that ETFs tracks the market index, thus if the AP tracking error is aligned exactly with the index the ETF tracks this might result in low spreads. The $Volume is increasing but the increase in trading activity is very small, also going back to the explanation if the tracking error of the ETFs to market index is correct the APs do not have to make any significant adjustments to ETFs holdings, hence trading activity is not significant.

The dummy variable RI (1-2) which is the two days before the federal rate announcement, we found that on average the relationship between the dummy and dependent variables is negative. The %Quoted spreads are not significant, %Effective spreads only the financial sector, utility sector and Allcaps are significant, Amihud illiquidity only consumer discretionary, consumer staples, industrials and Allcaps, $Volume only Financial sector are significant. The average increase in the %Effective spread on the two days prior to policy rate announcement is 0.0423%, the average Amihud illiquidity increase by 1.3367 and trading activity increases by $38 17. The dummy variable RI (0) for the day of the announcement the average relationship to dependent variables positive and it is significant to most of the sectors variables. The spread on the days of the policy rate announcement are increasing i.e. %Quoted spread are increasing by 0.0118%, %Effective spreads increase by 0.0204% and Amihud illiquidity is increasing by 0.9287, trading activity is increasing by $ 32 717. For ETFs, these results contradict other studies, what other studies looked at was the stock reaction to policy announcement as they expect that trading activity is positive on the two days prior to the announcement of the policy rate.

The intercept in all the regression in table 5 are statistically significant and they are negative to the measures of liquidity and positive for trading activity. This is consistent to practice that on average the spreads of ETFs are very low and hence ETFs are known to be one of the liquid

Table 3: Overall regression average daily liquidity measures

The table shows the dependent variables of liquidity proxies; percent quoted spread, percent effective spread, Amihud liquidity measure, and dollar volume. These dependent variables are calculated by taking the average of all eleven sectors (used in this study i.e. Table 5 panel A, B, C and D) with respect to the liquidity measures. The acronyms are kept the same as previous tables; %Quoted Spread, % Effective Spread, Amihud, $ Volume. The explanatory variables are short rate= (federal fund rate), term spread = (Federal fund rate - 10 years constant maturity Treasury bond yield), quality spread = (Moody's Baa corporate bond yield - 10 years constant maturity Treasury bond yield), VIX (volatility index is the standard deviation of market returns), and dummy variables RI (0) as the day of the policy announcement and RI (1-2) is the two days prior to policy announcement day. The names of the explanatory variables are kept the same for simplicity. Presented are the coefficients and their t- statistics. The levels of significance are presented by (***) for one percent, (**) for five percent and (*) for ten percent level of significance. The R squared, Durbin Watson statistics, Newey west lags are reported in the table. The dependent variables and explanatory variables are expressed in first differenced and second difference for $Volume, and it is transformed to monthly days, thus we used 150 observations.

	% Quoted Spread	% Effective Spread	Amihud	$ Volume ($million)
Short Rate	0.1083*	0.1183***	3.6657*	-0.0250*
	1.8666	3.9499	1.8658	-1.7924
Term Spread	0.0705**	0.0679***	2.3291**	0.0080
	2.4678	4.7579	2.3767	0.7040
Quality Spread	0.0785***	0.0726***	4.3299***	0.0648***
	4.436	5.052	3.0923	6.6010
VIX	0.0061**	0.0084***	0.3460***	-0.0095***
	2.4339	3.6012	8.0526	-23.3326
RI (0)	-0.0183	0.4369*	-7.8743	0.1203**
	-0.2269	1.7287	-0.7539	2.1750
RI (1-2)	0.1425**	-0.0562	9.7179**	0.0734**
	2.0645	-0.691	2.3424	2.5774
Intercept	-0.0070*	-0.0086**	-0.3246***	-0.0086***
	-1.9291	-2.3442	-3.3589	-8.2288
R-squared	0.5234	0.2069	0.6544	0.3767
Durbin-Watson Statistics	2.2104	2.7997	2.7477	2.6372
Newey west _lag	6	6	4	4

investment vehicles. Therefore when the asset is liquid trading activity will be higher hence positive $volume.

In appendix D table 5 we have seen that the R squares of the regressions are low and the explanatory variables do not determine very well the liquidity of the models only the trading activity that there is high significance in the determination of R squares. Moreover, there was an issue with positive autocorrelation reported by Durbin Watson. To remedy for these issues we have estimated an overall regression that averages all sectors. The data of these sector averages is then transformed to monthly data and for both dependent and independent variables we take the first difference to make the variables stationary and second difference for $Volume. The results are shown in table 3 below.

The relationship between the dependent variables and explanatory variables have not changed, it is positive for liquidity variables and negative for trading activity when regressed with short rate, term spread, quality spreads and VIX. The relationships are statistically significant at different levels of significance, however, the association between term spread and $Volume is no longer statistically significant. The dummy variable's relationship to dependent variables varies according to measures of liquidity and trading activity. The %Quoted spread and Amihud illiquidity have a negative association with dummy variable RI (0) and it is not statistically significant, but the relationship is positive with RI (1-2) and it is statistically significant. The %Effective spread has a positive association with dummy variable RI (0) and the relationship is statistically significant, but the relationship is negative with RI (1-2) and it is not statistically significant. $Volume has a positive association with dummy variable RI (0) and RI (1-2) the relationship is statistically significant. The intercept is statistically significant and the relationship is negative for liquidity measures and positive for $Volume.

When the effect has not changed in an instance of an increase in short rate, term spread, quality spread increase the liquidity of exchange-traded funds will decline followed by a decrease in trading activity. The term spread effect is lower than quality and short rate. The volatility reduces liquidity and trading activity but by small amounts. The inconsistency of the dummy variables of policy announcement to liquidity measures might be explained by the fact that the dependent variables might be capturing different effects, for example, if the policy rate announcement is expected the liquidity might not be pronounced and if the announcements are not expected we might find spreads going up as and trading activity going up on the day of the

unanticipated policy announcement date. We find evidence that trading activity is increasing prior to policy rate announcement and on the day of the announcement.

The R squared have been improved for the %Effective spread and Amihud illiquidity, and it has declined for $Volume. The Durbin Watson have also improved and we can accept the null hypothesis that there is no autocorrelation for liquidity measures and trading activity.

Overall we find that interest rates changes have a significant effect on the liquidity of Exchange-traded funds the spreads tend to be higher with increasing interest rate. Moreover, we find that the term spreads and quality spread also have an impact on ETFs liquidity, the volatility index effect is positive but the magnitude of the effect is very low. The federal rate announcement dates also affect the liquidity, trading activity is also affected by interest rates changes and policy rate announcements. The previous studies suggested that the interest rates sensitive sectors i.e. Utility sector, financial sector and real estate sector, are most affected by changes in interest rates, however, with ETFs we find little evidence that these sectors react more to changes in interest rates than other sectors. The Real estate sector exhibit high spreads but also consumer discretionary sector tends to have higher spreads as well. For utility and financials, the average spread increase is almost the same as the average increase of other sectors.

In essence, we accept the null hypothesis (H_{1a}) which stated that when interest rates increase the liquidity of exchange-traded funds will decrease. We reject the null hypothesis (H_{2a}), which states that liquidity of ETFs sectors that are interest rate sensitive will significantly decrease, from the day following the announcement of interest rate hikes, resulting in the reduced liquidity of those ETFs. In table 5 we found evidence that ETFs liquidity of the sensitive sectors to interest rates only decline on the day of policy rate announcement. Also, the results showed that interest rate sensitive sectors on ETFs experience a decrease in liquidity that is in line with other sectors, their liquidity decrease is in line with other sectors.

Conclusion

In conclusion, we find that ETF liquidity is affected by short term interest rates We find that on average ETFs spreads are relatively low, less than one percent. However, Amihud illiquidity exhibit high illiquidity, this might be because of the small bid and ask price being closer to market price making the holding period returns smaller and the denominator dollar volume larger. We also find that trading activity measures are relatively close to each other, i.e. $volume and share volume.

We find that the liquidity measures respond positively and significantly on increase in short rate. The liquidity of ETFs decreases with increasing interest rates. These results are consistent with Chordia et al. (2001) and Fernández-Amador et al. (2011) who predicts that monetary policy regime creates uncertainty in the market leading to volatile markets. Contrary to Malik (2015) we found that the interest rate sensitive sectors on ETFs tend to have the same average decrease in liquidity relative to other sectors. The underperformance of the ETFs sectors is relatively the same, unlike individual stock where declining liquidity is more pronounced in these sectors. Furthermore, term spreads and quality spreads also negatively affect the liquidity of ETFs. Consistent with Calamia et al. (2014) we find evidence that high volatility has a negative effect on the liquidity of ETFs. Increase in volatility leads to an increase in spreads which translate to low liquidity

The macroeconomic announcement of federal fund rate has an influence on liquidity measures of ETFs but this effect varies from the day of the announcement and days prior to the announcement. In this paper we assumed that the monetary policy announcement date is known in advance by the market participants and adjustment is supposed to be made in advance to accommodate the changes in short rate. However, we find differing results on liquidity measures regarding the announcement days. To seek for the solution we look at the trading activity of the dummy variables of federal rate announcements and we find that trading activity occurs in both scenarios, trading increase on the two days before policy announcement and on the day on the policy announcement. Furthermore, the finding of this paper suggests otherwise to Vanguard (2015) notion that trading volume becomes an insignificant indicator for the overall ETF liquidity since APs have the authority to redeem the shares at any point necessary. This is true when AP makes inventory adjustment. Otherwise, trading activity is also affected by interest rates volatility and policy announcements.

The limitations that we faced on this paper is that theoretical studies that explain the liquidity of exchange-traded fund and various factors is still at early stages since ETFs have recently been popular after 2006 as more of them were created. This leaves us with empirical studies that have studied ETFs liquidity factors as underlying asset liquidity, size, expense ratios, etc. and factors such as microeconomic variables, the interest rates effect have not been given full attention little have been studied. Hence in this paper, the reference papers that we have used are more on market liquidity and stock liquidity relationship with ETFs. Therefore making it hard to make the most significant comparison, since liquidity of ETFs is also affected by underlying stock liquidity and market liquidity of the benchmark the ETF tracks, there might be some biases with these comparisons.

For trading activity, further studies should be conducted to see if the increase in trading volume is due to secondary market trading or the Authorized Participants intervention to make the adjustment for liquidity. There is still more room for research on liquidity effects of exchange-traded funds and interests rate changes is one of them.

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Appendix

Appendix A: ***List of ETFs, names tickers and inception dates***

Ticker	ETF name	Inception date
	Utilities Sector	
XLU	Utilities Select Sector SPDR Fund	1998-12-16
IDU	iShares U.S. Utilities ETF	2000-06-20
VPU	Vanguard Utilities ETF	2004-01-30
PUI	Invesco DWA Utilities Momentum ETF	2005-10-26
	Technology Sector	
XLK	Technology Select Sector SPDR Fund	1998-12-16
IYW	iShares U.S. Technology ETF	2000-05-19
XNTK	NYSE Technology ETF	2000-09-29
IGM	iShares North American Tech ETF	2001-03-13
SOXX	iShares PHLX Semiconductor ETF	2001-07-10
IGV	iShares North American Tech-Software ETF	2001-07-10
VGT	Vanguard Information Technology ETF	2004-01-30
PSI	Invesco Dynamic Semiconductors ETF	2005-06-23
PSJ	Invesco Dynamic Software ETF	2005-06-23
	Financial Sector	
XLF	Financial Select Sector SPDR Fund	1998-12-16
IYF	iShares U.S. Financials ETF	2000-05-31
IYG	iShares U.S. Financial Services ETF	2000-06-21
VFH	Vanguard Financials ETF	2004-01-30
KBE	SPDR S&P Bank ETF	2005-11-15
KIE	SPDR S&P Insurance ETF	2005-11-15
KCE	SPDR S&P Capital Markets ETF	2005-11-15
	Consumer Discretionary Sector	
XLY	Consumer Discretionary Select Sector SPDR Fund	1998-12-16
	Energy Sector	
XLE	Energy Select Sector SPDR Fund	1998-12-16
IYE	iShares U.S. Energy ETF	2000-06-12
IGE	iShares North American Natural Resources ETF	2001-10-26
VDE	Vanguard Energy ETF	2004-09-23
PXE	Invesco Dynamic Energy Exploration & Production ETF	2005-10-26
PXJ	Invesco Dynamic Oil & Gas Services ETF	2005-10-26
	Health and Biotech Sector	
XLV	Health Care Select Sector SPDR Fund	1998-12-16
IYH	iShares U.S. Healthcare ETF	2000-06-12
IBB	iShares Nasdaq Biotechnology ETF	2001-02-05
VHT	Vanguard Healthcare ETF	2004-01-30
PJP	Invesco Dynamic Pharmaceuticals ETF	2005-06-23
PBE	Invesco Dynamic Biotechnology & Genome ETF	2005-06-23
	Industrial Sector	
XLI	Industrial Select Sector SPDR Fund	1998-12-16
IYJ	iShares U.S. Industrials ETF	2000-07-14
VIS	Vanguard Industrial ETF	2004-09-23
PPA	Invesco Aerospace & Defense ETF	2005-10-26
	Material Sector	
XLB	Materials Select Sector SPDR ETF	1998-12-16
IYM	iShares U.S. Basic Materials ETF	2000-06-20
VAW	Vanguard Materials ETF	2004-01-30
	Real Estate Sector	
IYR	iShares U.S. Real Estate ETF	2000-06-12

IYC	iShares US Consumer Services ETF	2000-06-28
VCR	Vanguard Consumer Discretionary ETF	2004-01-30
PEJ	Invesco Dynamic Leisure and Entertainment ETF	2005-06-23
PBS	Invesco Dynamic Media ETF	2005-06-23
	Consumer Staples Sector	
XLP	Consumer Staples Select Sector SPDR Fund	1998-12-16
IYK	iShares U.S. Consumer Goods ETF	2000-06-12
VDC	Vanguard Consumer Staples ETF	2004-01-30
PBJ	Invesco Dynamic Food & Beverage ETF	2005-06-23

ICF	iShares Cohen & Steers REIT ETF	2001-01-29
RWR	SPDR Dow Jones REIT ETF	2001-04-23
	All Caps ETFs	
VNQ	Vanguard Real Estate Index Fund	2004-09-23
IWR	iShares Russell Midcap ETF	2001-07-17
IWS	iShares Russell Midcap Value ETF	2001-07-17
IWP	iShares Russell Midcap Growth ETF	2001-07-17
VXF	Vanguard Extended Market VIPERs ETF	2002-01-04
PWC	Invesco Dynamic Market ETF	2003-05-01
FVL	First Trust Value Line 100 ETF	2003-06-12
VOX	Vanguard Communication Services ETF	2004-09-23
PEY	Invesco High Yield Equity Dividend Achievers™ ETF	2004-12-09

Appendix B

Table 4: Correlation matrix of average daily exchange-traded funds liquidity variables

The results show the correlation of measures of liquidity variables. The acronym Quoted spread $, %Quoted Spread, Effective Spread$, and % Effective Spread, Amihud, Share Volume, Dollar Volume and price represent the daily average ETF liquidity of 11 sectors. The share volume and dollar volume are logged. Furthermore, the table demonstrates the correlation between the explanatory variables. From the table, we can also observe the significance levels of correlation.

Correlation Probability	$ Quoted Spread	% Quoted Spread	$ Effective Spread	% Effective Spread	Amihud	$ Volume ($million)	Share Volume (million)	Price
$ Quoted Spread	**1**							

% Quoted Spread	0.931	**1**						
	0.000	---						
$ Effective Spread	0.606	0.5209	**1**					
	0.000	0.0000	---					
% Effective Spread	0.448	0.4614	0.9099	**1**				
	0.000	0.0000	0.0000	---				
Amihud	0.570	0.6969	0.3338	0.3401	**1**			
	0.000	0.0000	0.0000	0.0000	---			
$ Volume ($million)	-0.499	-0.4921	-0.2716	-0.2226	-0.3942	**1**		
	0.000	0.0000	0.0000	0.0000	0.0000	---		
Share Volume (million)	0.127	0.2776	0.1078	0.1565	0.4171	0.0906	**1**	
	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	---	
Price	-0.340	-0.4711	-0.1217	-0.1990	-0.4650	0.8577	-0.2124	**1**
	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---

Appendix C: ***Sector averages for interest rate sensitive sectors, includes Allcaps for comparison***

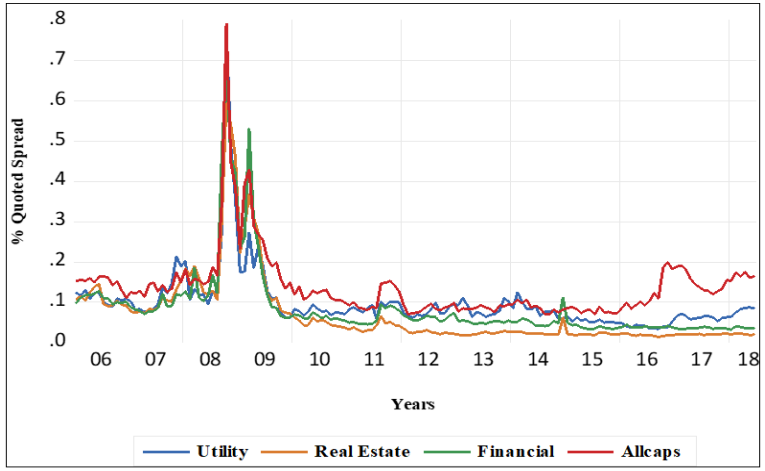

Figure 6: Average % quoted spread

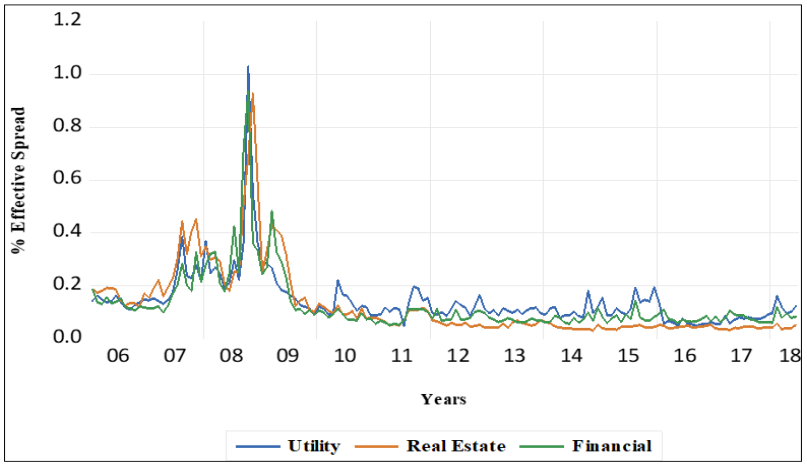

Figure 7: Average % effective spreads spread

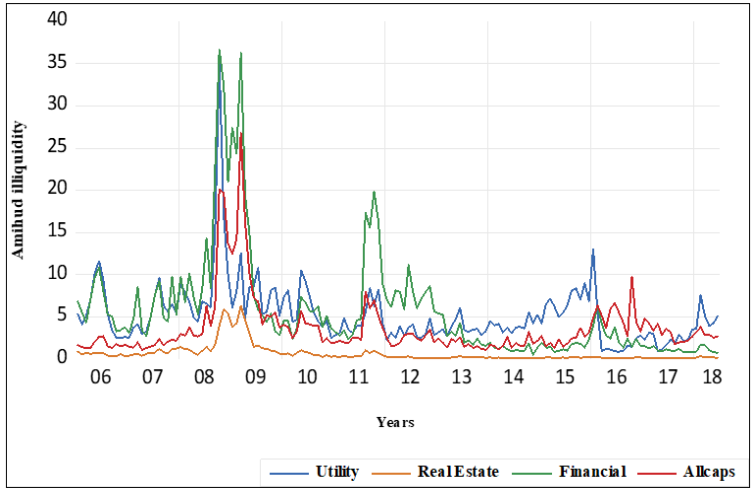

Figure 8: Average Amihud illiquidity

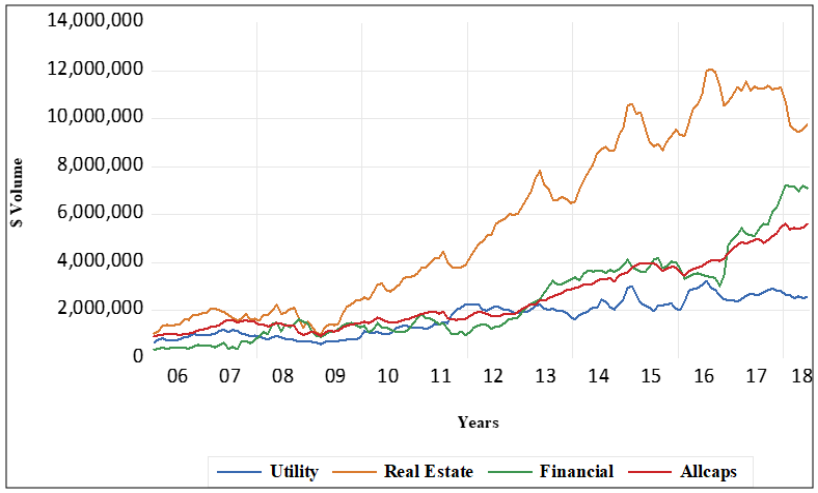

Figure 9: Average $ Volume

Appendix D

Table 5: Daily sector averages of exchange-traded funds.

The dependent variables are daily liquidity sectors of exchange-traded funds. The liquidity values of these sectors are constructed by averaging the exchange-traded funds with their respective sectors. The acronyms in panel A, B, C, and D; Utility, Financial, Real estate, Technology, Consumer Discretionary, Consumer Staples, Energy, Health and Biotech, Industrial, Material, and Allcap denote the i. The % quoted spread = closing ask price –closing bid price divided by the midprice of the bid and ask price, % effective spread = absolute value of closing price –midprice of bid and ask price multiply by two, Amihud = absolute daily return divided by dollar volume (multiply the Amihud by on million to accommodate the difference in values between returns and volume), and $volume= number of outstanding shares on the day of trade times closing price. The explanatory variables are short rate= (federal fund rate), term spread = (Federal fund rate - 10 years constant maturity Treasury bond yield), quality spread = (Moody's Baa corporate bond yield - 10 years constant maturity Treasury bond yield), VIX (volatility index), and dummy variables RI (0) as the day of the policy announcement date and RI (1-2) are the two days prior to policy announcement day. The names of the explanatory variables are kept the same. The computation of explanatory variables is consistent with panels, A, B, C and D. Presented are the coefficients and their t- statistics. The levels of significance are presented by (***) for one percent, (**) for five percent and (*) for ten percent level of significance. The R squared, Durbin Watson statistics, Newey west lags are reported on the table. The number of observations used are 3145.

Panel A: % Quoted Spreads

	% Quoted Spreads										
	Utility	Financial	Real Estate	Technology	Consumer Discretionary	Consumer Staples	Energy	Health & Biotech	Industrial	Material	AllCaps
Short Rate	0.0209***	0.0332***	0.0442***	*0.0352****	*0.0429****	0.0308***	0.0280***	0.0333***	0.0312***	0.0304***	0.0197***
	11.4334	5.8854	6.538	5.6031	6.9196	8.5748	5.6689	10.5424	9.8378	9.3515	5.3923
Term Spread	0.0105***	0.0176***	0.0264***	*0.0198***	*0.0282****	0.0168***	0.0068	0.0210***	0.0182***	0.0144***	0.0114**
	4.7577	3.0949	3.6888	*2.5457*	*2.9962*	3.7159	1.2188	5.1695	4.1831	3.5548	2.5115
Quality Spread	*0.0165***	0.0569***	0.0615***	*0.0466***	*0.0369****	0.0266***	0.0232*	0.0335***	0.0362***	0.0405***	0.0112
	2.5189	4.255	5.3335	2.3722	2.6333	3.2116	1.8019	3.6067	4.2519	5.5256	1.1378
VIX	0.0057***	0.0044**	0.0041**	*0.0065**	*0.0067****	0.0047***	0.0076***	0.0042***	0.0042***	0.0039***	0.0063***
	5.7151	2.532	2.5719	1.8295	2.7518	2.8152	3.4216	2.6399	2.9111	3.1978	3.942
RI (0)	0.0147*	0.0062*	0.0101**	*0.0085**	*0.0185***	0.0125***	0.0168***	0.0089**	0.0142**	0.0075**	0.0135
	1.7488	1.8303	2.2756	*1.8209*	*2.4471*	3.7107	2.7406	2.1267	2.2743	2.1754	1.6013
RI (1-2)	*-0.0013*	-0.0013	0.0029	*-0.0047*	*0.0087*	0.0013	-0.0031	0.0011	-0.0008	-0.0032	-0.0061
	-0.2445	-0.321	0.6126	-0.7962	0.8805	0.33	-0.5291	0.2946	-0.2895	-1.0089	-0.9044
Intercept	-0.0999***	-0.2244***	-0.2748***	*-0.2140****	*-0.2174****	-0.1395***	-0.1439***	-0.1631***	-0.1669***	-0.1803***	-0.0573**
	-10.0559	-5.7033	-7.0671	-5.3958	-6.7186	-6.1139	-5.3435	-7.6631	-9.9171	-8.4042	-2.1168
R-squared	0.4014	0.5134	0.6654	0.3989	0.4052	0.5400	0.4705	0.5369	0.5917	0.6065	0.4006
Durbin Watson Statistics	0.7043	0.8584	1.0207	0.7888	1.4011	1.0869	0.8181	1.0595	0.9906	0.9935	0.9199
Newey west lag	0	5	5	4	6	8	1	4	8	6	5

Panel B: % Effective Spreads

	% Effective Spreads										
	Utility	Financial	Real Estate	Technology	Consumer Discretionary	Consumer Staples	Energy	Health & Biotech	Industrial	Material	AllCaps
Short Rate	0.0205***	0.0372***	0.0673***	0.0201***	0.0546***	0.0393***	0.0355***	0.0470***	0.0426***	0.0493***	-0.0817**
	3.1949	5.9705	9.8087	7.7089	9.7626	11.1831	5.4056	7.5007	9.3171	9.0657	-2.0454
Term Spread	-0.001	0.0096	0.0287***	-0.0063*	0.0239***	0.0148***	-0.0041	0.0264***	0.0154***	0.0235***	-0.1578**
	-0.1404	1.3395	3.6738	-1.8861	3.5052	3.7701	-0.6313	3.6874	2.936	3.6054	-2.5071
Quality Spread	-0.0003	0.0435***	0.0675***	0.0353***	0.0662***	0.0203*	0.0115	0.0326*	0.0414***	0.0385***	0.1028
	-0.0154	3.2909	4.2481	5.2606	4.7184	1.8663	0.5401	1.8487	3.2986	2.9176	1.1018
VIX	0.0096***	0.0065***	0.0073***	0.0087***	0.0114***	0.0083***	0.0087**	0.0088***	0.0069***	0.0075***	-0.0005
	3.095	4.9937	4.3478	10.2816	6.113	4.765	2.566	2.6909	3.6548	3.9614	-0.071
RI (0)	0.0469***	0.0328***	0.0096	0.0408***	0.0480***	0.0409**	0.0278**	0.0349**	0.0389***	0.0082	-0.1276**
	3.6169	4.9503	1.4793	2.8116	2.6021	2.2418	2.446	2.1942	3.084	1.138	-2.5248
RI (1-2)	-0.0105*	0.0135**	-0.0039	0.0015	0.0027	-0.0047	-0.0114	-0.0035	-0.0026	0.0093	-0.1298***
	-1.6945	2.4998	-0.7423	0.155	0.2072	-0.505	-1.249	-0.5059	-0.3158	0.5734	-2.6654
Intercept	-0.0631*	-0.1793***	-0.3281***	-0.1175***	-0.3483***	-0.1641***	-0.0804***	-0.2282***	-0.2027***	-0.2311***	0.4029*
	-1.7047	-5.2568	-8.7171	-6.2469	-8.1122	-7.7781	-2.7873	-5.0547	-7.5577	-6.5641	1.9188
R-squared	0.3761	0.3833	0.538	0.4427	0.4745	0.4176	0.3578	0.4696	0.4682	0.4104	0.0026
Durbin-Watson Statistics	1.4426	1.1127	1.328	1.2834	1.723	1.2717	1.2213	1.1195	1.3961	1.4657	2.0809
Newey west lag	5	8	6	0	2	2	4	3	3	3	6

Panel C: Amihud liquidity measure

	% Amihud illiquidity										
	Utility	Financial	Real Estate	Technology	Consumer Discretionary	Consumer Staples	Energy	Health & Biotech	Industrial	Material	AllCaps
Short Rate	0.5789***	0.7017**	0.3588***	-0.1877	9.8727***	1.1923***	-2.2666***	0.3787***	0.4465***	0.7891***	-0.0559
	3.2713	2.4768	6.0547	-0.8146	6.4849	9.4189	-7.3775	7.129	3.6487	11.0246	-0.2791
Term Spread	0.7039***	-0.9056**	0.2411***	-0.4897*	6.4008***	0.3857**	-3.2625***	0.4041***	0.1708	0.1775**	-0.2855
	3.2044	-2.3257	3.7945	-1.66	3.3703	2.4268	-7.1092	5.5772	1.1581	2.0346	-1.1925
Quality Spread	-1.2710***	2.3055**	0.6645***	1.4892***	21.3798***	-0.4940**	-1.2061*	-0.2424*	0.7831***	0.9517***	1.2637**
	-2.7252	2.1867	3.9216	2.6629	5.663	-2.0507	-1.7163	-1.7538	2.7461	6.5285	2.1295
VIX	0.3891***	0.5243***	0.0539***	0.5383***	1.3133***	0.2318***	0.4582***	0.1632***	0.2258***	0.1744***	0.2510***
	5.5374	8.8916	5.2462	9.7514	3.3567	8.9696	5.3082	12.5505	9.0969	7.1535	5.8262
RI (0)	1.1247*	2.0671**	0.1679**	-0.6008	4.4066	0.8844*	0.435	0.3992*	0.1172	0.2711	0.1163
	1.8938	2.4948	2.271	-0.7657	1.6297	1.9454	0.5778	1.8832	0.2864	1.0188	0.3521
RI (1-2)	0.0875	-0.1996	-0.0462	-1.224	-3.6294**	-0.4032*	-0.1342	-0.1614	-0.5961**	-0.1002	-0.7180***
	0.2122	-0.3661	-0.557	-2.4148**	-2.0321	-1.795	-0.3092	-1.2035	-2.2934	-0.4258	-2.7131
Intercept	-0.6697	-9.9670***	-3.0459***	-5.4335***	-91.1975***	-2.2552***	9.8175***	-1.4411***	-4.0029***	-5.1654***	-3.9799**
	-0.5762	-4.205	-6.753	-4.1798	-8.9286	-4.0422	5.5703	-4.6135	-6.0645	-14.8409	-2.507
R-squared	0.2452	0.4506	0.5139	0.4073	0.5232	0.4229	0.2109	0.3621	0.3601	0.4534	0.3728
Durbin-Watson Statistics	1.7793	1.8087	1.642	1.9578	1.8607	1.9768	1.5485	1.9202	1.9112	1.8366	1.5396
Newey west lag	3	7	4	2	5	5	8	1	3	1	2

Panel D: $ Volume

	$ Volume										
	Utility	Financial	Real Estate	Technology	Consumer Discretionary	Consumer Staples	Energy	Health & Biotech	Industrial	Material	AllCaps
Short Rate	-0.4676***	-0.5862***	-0.6922***	-0.7216***	-0.9048***	-0.6526***	-0.3277***	-0.6096***	-0.6648***	-0.3735***	-0.4211***
	-11.5591	-7.118	-9.2658	-4.6656	-4.6562	-16.276	-11.3227	-11.5332	-10.3516	-12.802	-11.1341
Term Spread	-0.4950***	-0.3679***	-0.6141***	-0.5749***	-0.7557***	-0.6094***	-0.2646***	-0.6076***	-0.4912***	-0.1902***	-0.3733***
	-4.9154	-3.5282	-6.2239	-3.1128	-3.4046	-13.8765	-6.2712	-7.945	-5.393	-5.0977	-7.6915
Quality Spread	-0.3141***	-0.4333**	-0.4803***	-0.6308*	-0.6710*	-0.3202***	-0.3005***	-0.4531***	-0.6931***	-0.5109***	-0.4034***
	-6.0484	-2.45	-7.4408	-1.9331	-1.6886	-2.8316	-5.2757	-3.9305	-5.3553	-8.5364	-5.1526
VIX	0.0001	0.0033	-0.005	0.0048	-0.0019	0.0021	0.0014	-0.0017	0.0072	0.006	0.0021
	0.0397	0.217	-0.4297	0.346	-0.0622	0.274	0.3059	-0.161	0.6319	1.2453	0.3139
RI (0)	-0.0068	0.0410*	0.008	0.0265	0.0163	0.0036	0.0239**	0.0162	0.0333*	0.0202	0.0181
	-0.6155	1.9234	0.2897	0.5185	0.3887	0.2895	1.9793	0.7575	1.6622	1.4383	1.255
RI (1-2)	-0.0099	0.0382*	0.0074	0.022	0.0137	0.0067	0.0158	0.0139	0.0241	0.0152	0.0116
	-1.2907	1.7586	0.2787	0.4751	0.4267	0.5195	1.297	0.6785	1.2053	1.0475	0.8344
Intercept	16.5199***	16.8694***	18.5850***	17.6453***	17.8413***	16.8577***	16.2227***	17.5139***	17.4613***	16.0205***	16.8056***
	127.8599	34.5508	41.8826	13.7766	14.5441	59.5586	105.7808	58.0693	48.6614	98.8665	80.5464
R-squared	0.893	0.6290*	0.8678	0.8191	0.7865	0.8374	0.6923	0.6342	0.7449	0.7621	0.6809
Durbin-Watson Statistics	0.0633	0.0102	0.0195	0.0164	0.01	0.0201	0.0195	0.0062	0.0128	0.0228	0.0119
Newey west lag	7	13	5	4	7	7	8	5	12	4	5