EXCHANGE TRADED FUNDS AND INDEX ANALYSIS: VOLATILITY AND OPTIONS

Stoyu I. Ivanov, University of Nebraska - Lincoln
Yi Zhang[1], Prairie View A&M University

Abstract

Exchange Traded Funds (ETFs) track their underlying index closely and are relatively inexpensive instruments for risk diversification. We examine the volatility of the three most liquid ETFs (DIA, SPY and QQQQ) and their tracking indexes (DOW, S&P 500 and NASDAQ 100). We find no significant difference in the realized return volatility between ETFs and indexes even controlling for nonsynchronous trading. However, as the best predictor of volatility, the option-implied volatility of ETFs is significantly different from that of indexes. We further examine the implied volatility function of stock options and index options using unique pair samples of ETFs and their tracking indexes. We find that the differential implied volatility function is related to open interest. Our results are consistent with the net buying pressure theory proposed by Bollen and Whaley (2002), and inconsistent with the argument of Bakshi, Kapadia and Madan (2003) which attributes the difference to differential return distributions. Our study also explores whether ETF options are used more for speculation or hedging, and whether they are a viable, stand alone new investment opportunity or they are just an alternatives to index options.

[1] Corresponding author, Department of Accounting, Finance & MIS, Prairie View A&M University, Prairie View, TX 77446, Phone: (936)261-9219, Email: yizhang@pvamu.edu

1. Introduction

Exchange Traded Funds (ETFs) appear to be a relatively cheap instrument for diversification in terms of direct costs. They have become an important investment vehicle to both professional and individual investors as evident from the Investment Company Institutes' (ICI) statistics. ICI reports that there were 80 ETFs in 2000 and 359 ETFs in 2006, a 350% increase. The ETF assets also increased significantly in that period from $65.59 billion in 2000 to $422.55 billion in 2006, an increase of 544% for the period. However, most literature on ETFs focuses on their tracking errors and very little research has been conducted in the area of variability of ETFs which has a greater importance for risk diversification. We attempt to fill this void by studying the volatility of ETFs relative to their underlying indexes.

ETFs are passive investment vehicles. The ETF manager closely tracks the yield and price of the underlying index by holding either the contents of the index or a representative sample of the securities in the index. The proportions and exact composition of the ETF portfolio might differ from that of the underlying index since minimization of costs might result in difference in the composition of ETF portfolio and index. Additionally, ETFs accumulate dividends in a non-interest bearing account and distribute accumulated dividends in a lump sum periodically. Also, ETFs keep on trading after hours until 4:15pm while indexes are reported at 4:00pm. These differences may cause a deviation of the return of an ETF from the return of its underlying index. In this study we examine not only the mean deviation of the return of an ETF from the return of its underlying index, but the whole return distribution. We focus on the higher moments of return – volatility, skewness and kurtosis. Our sample includes the three most liquid and well-known ETFs: DIA, SPY and QQQQ. These ETFs are tracking the yield and price of the Dow Jones Industrial Average, S&P 500 and NASDAQ 100 respectively. Using realized daily returns over more than six-year period, we find insignificant difference in the return distributions of ETFs and indexes.

An alternative way to approach risk is by using the options' implied volatility. Previous studies suggest that the implied volatility of an option is a good predictor of the underlying asset's future volatility. For example, VIX (a measure of the implied volatility of S&P 500 index options) is widely used to estimate the market volatility. We thus examine the implied volatility of ETF options and their corresponding index options. ETFs are traded like stocks so ETF options are stock options. Bakshi, Kapadia, and Madan (2003) attribute the differential implied volatility function of stock options and index options to the differential return distributions of the underliers. Since ETFs track their underlying index closely and are not significantly different from their underlying index in the return distribution, using ETF options and index options produces a unique sample to explore the implied volatility of stock options versus index options.

We find that the implied volatility level (the implied volatility of at-the-money options) of ETF options is significantly different from that of index options. The implied volatility level of SPY and QQQQ is higher than that of S&P 500 and NASDAQ 100 respectively; while the implied volatility level of DIA is lower than that of Dow Jones Industrial Average. We also find that the shape of the implied volatility function (volatility smile/skew) is different between ETF options and index options, and is related to open interest. Our results are consistent with the argument of Bollen and Whaley (2004) that the implied volatility function is related to the net buying pressure of options.

Net buying pressure is related to investor speculative or hedging demand for options. Therefore, we attempt to find whether ETFs are more often used for speculative or hedging purposes. Index options are widely used for hedging purposes (Evnine and Rudd, 1985) at the same time Moran (2003) suggests that ETFs are used widely for hedging purposes of long term risk exposures of highly concentrated portfolios. However, the speculative motive for trading ETFs cannot be ruled out. Theoretically, examining the option's open interest provides insight on the use of options. Put options are widely used for downside protection. Especially out-of-the-money puts are low-cost instruments for hedging. Call options provide upside potential and thus out-of-the-money calls are more likely used for speculation. Therefore, we perform univariate and multivariate tests on the open interest and put/call ratio of ETF options and index options to find whether ETF options are just alternatives to index options or they produce new investment opportunity.

The paper contributes to the literature in the following ways. First, the paper fills the void of volatility in the literature of ETFs, which plays an important role in risk diversification. We examine both the realized return volatility and the option implied volatility – a valid predictor of future volatility. Second, the paper adopts a unique sample to reexamine the net buying pressure theory of Bollen and Whaley (2004). The advantage of using pair samples of ETF options and index options is that return distributions of ETFs are insignificantly different from their tracking indexes. Therefore, the difference in implied volatility functions between ETFs and indexes can be attributed to other factors than return distribution difference, such as net buying pressure. Third, we attempt to explore the use of ETFs for hedging or speculation. It is interesting to know whether ETF options provide new investment opportunities or they are just an alternative to index options.

The paper is organized as follows: Section 2 examines the related literature and develops the research scope of the paper. Section 3 describes the data and empirical methodology. Section 4 presents empirical results and Section 5 concludes.

2. Literature Review and Research Development

ETFs are exploding in popularity. However, most literature on ETFs focuses on their tracking error (for example, Poterba and Shoven, 2002; and Engle and Sarkar, 2006). To our knowledge there are no studies focused on the volatility of ETFs. Pontiff (1997) conducts a study of the excess volatility characteristics of closed-end funds. Pontiff finds that closed-end funds are more volatile than the underlying securities. The excess risk in closed-end funds is predominantly idiosyncratic risk and to a smaller extent due to market, small-firm and common closed-end family of funds risks. Closed-end funds are similar to ETFs in that both are traded on a stock exchange throughout the trading day, but ETFs are structured differently from closed-end funds. For example, ETFs are legally structured to resemble open end funds in the sense that new ETF securities can be issued.

We study the volatility of ETFs with respect to their underlying indexes. Since ETFs are passive portfolios tracking an index, there should not be much difference in the variability of the ETF and the index. Nevertheless, ETFs accumulate dividends and then distribute accumulated dividends in a lump sum periodically. For example SPY and QQQQ distribute dividends quarterly and DIA pays dividends monthly. Also ETFs lack short-sale constraints. In addition, ETFs keep on trading after hours until 4:15pm when their underlying indexes are reported at 4:00pm. These characteristics of ETFs might suggest difference in the volatility of ETFs and their underlying indexes. Therefore, we empirically compare the variance, skewness and kurtosis of ETFs and their underlying indexes using realized daily returns. Considering the nonsynchronous ETF prices and index levels at closes, we also use synchronized price data.

The option implied volatility is shown to do a better job in predicting future volatility than past realized volatility by Christensen and Prabhala (1998) and others. We thus investigate the implied volatility of ETF options and index options, as well. Since past realized volatility of ETFs are insignificantly different from that of indexes, the implied volatility is not expected to be different. However, ETFs are traded like stocks so that ETF options are considered stock options. Existing literature on the implied volatility shows that the implied volatility function of stock options is different from that of index options. Bakshi, Kapadia, and Madan (2003) study the S&P 100 options and the 30 largest stocks in the index and find index volatility smile (the variation of the implied volatility across strike prices) are more negatively sloped than individual stock volatility smiles. They show that this difference comes from the more skewed return distribution of individual stocks. Hence, we first test whether ETF options' and underlying indexes options' implied volatility functions differ due to the differential return distributions of ETFs and indexes.

ETFs closely track the performance of their underlying indexes, which will make their return distribution similar to indexes. If this is the case, we have unique pair samples which are free from differential return distributions to examine the implied volatility function of stock options versus index options. Despite the similarity in the volatility characteristics of indexes and ETFs, there might be a difference in the implied volatility function between index options and ETF options. This difference, if exists, can be attributed to other factors than return distributions, such as net buying pressure proposed by Bollen and Whaley (2004). Bollen and Whaley argue that option prices and implied volatilities are affected by the demand for options. When arbitrage is limited, the option supply curve is upward sloping so that the shape of the implied volatility function is related to the net buying pressure from public order flows. Bollen and Whaley study both index options and stock options and find that changes in the implied volatility of S&P 500 options are most strongly affected by buying pressure for index puts while changes in implied volatility of stock options are dominated by call option demand.

Options are low cost instruments for hedging or speculation. It would be interesting to know the major use of ETF options and we are the first to explore this question. Are they mostly used for hedging or speculation? Are they just alternatives to index options or new investment instruments for investors? To answer these questions, we examine, consistent with the existing finance literature, the open interest of options with various categories of moneyness. Buraschi and Jackwerth (2001) show that options are used for different purposes, i.e. speculative or hedging purposes, depending on the option type or moneyness (away-from the money options or at-the-money options). Additionally, Lakonishok et al. (2004) find that the least sophisticated investors were using equity options for speculation during the Bubble period and the sophisticated investors were speculating moderately at this time.

3. Data and Methodology

We study three ETFs: the Spider (SPY), the Diamonds (DIA), and the Cubes (QQQQ after 12/01/2004 and QQQ before 12/01/2004)[2]. Data for the ETFs (DIA, SPY & QQQQ) and the S&P500 index are obtained from the Center for Research in Security Prices (CRSP). We obtain the data of the Dow Jones Industrial Average (DJIA) from http://djindexes.com, and the data of the NASDAQ100 index from http://dynamic.nasdaq.com. The stock market closes at 4:00pm and the indexes are reported at 4:00pm, but ETFs and options close trading at 4:15pm. Thus, to align the trading periods prices are synchronized by obtaining last trading price of the ETF at market close at 4:00pm from NYSE TAQ database. When closing prices are used, we examine DIA and SPY from 10/01/1998 until 12/30/2005, QQQQ from 03/10/1999 until 12/30/2005. When prices are synchronized, the study periods for DIA and SPY are from 01/04/1999 to 12/29/2006, and for the QQQQ are from 03/10/1999 to 12/30/2005.

We use options data from the Chicago Board Options Exchange (CBOE) from 2003 to 2006 provided by deltaneutral.com. We use the Dow Jones index options (DJX), the S&P500 index options (SPX) and the NASDAQ 100 index options (NDX). All of these options are European options. Index options expire on the Saturday following the third Friday of the contract month and are cash-settled at the special quotation. ETF options are American options. The options data are filtered based on the criteria suggested by Day and Lewis (1988), and Xu and Taylor (1994). The options used to form the sample are required to meet the following criteria:

a) expiration greater than 7 days and less than 30 days from the trading date;
b) the boundary conditions of index options should follow European option boundary conditions: $c < Se^{-R_f T} - Xe^{-R_d T}$ and $p < Xe^{-R_d T} - Se^{-R_f T}$;
c) the boundary conditions of ETF options should follow American option boundary conditions: $C < S - X$ and $P < X - S$;
d) should not be far out or in the money so that: hedging delta for call option is between 0.02 and 0.98 and hedging delta for put option is between -0.02 and -0.98.

These criteria were used so that options would not exhibit thin trading and extreme volatility, and would not exhibit riskless arbitrage opportunities which will endanger the soundness of the conclusions. For the classification of moneyness we utilize the Bollen and Whaley (2004) categories based on options' delta (see table 1).

To investigate the potential differences in the implied volatility function of index options versus stock options, we consider several possible explanations:

1. ETFs and indexes have different return distributions as argued by Bakshi, Kapadia, and Madan (2003).
2. ETF options are American options while index options are European options;
3. Transaction costs, the bid-ask spread is larger for index options compared to ETF options.

[2] The change in symbol was due to the migration of trading of Cubes from AMEX to NASDAQ.

4. The demand for options, proxied by the open interest, is different for ETF options and index options.

Table 1
Moneyness Category

Category	Labels	Range
1	Deep-in-the-money (DITM) call Deep-out-of-the-money (DOTM) put	$0.875<\Delta c<=0.98$ $-0.125<\Delta p<= -0.02$
2	In-the-money (ITM) call Out-of-the-money (OTM) put	$0.625<\Delta c<=0.875$ $-0.375<\Delta p<= -0.125$
3	At-the-money (ATM) call At-the-money (ATM) put	$0.375<\Delta c<=0.625$ $-0.625<\Delta p<= -0.375$
4	Out-of-the-money (OTM) call In-the-money (ITM) put	$0.125<\Delta c<=0.375$ $-0.875<\Delta p<= -0.625$
5	Deep-out-of-the-money (DOTM) call Deep-in-the-money (DITM) put	$0.02<\Delta c<=0.125$ $-0.98<\Delta p<= -0.875$

Thus we perform univariate and multivariate tests on the implied volatility function. The multivariate model that we employ in the analysis is:

$$\textit{Implied Volatility} = \beta_0 + \beta_1 \textit{(open interest)} + \beta_2 \textit{(option volume)} + \beta_3 \textit{(bid-ask spread)} + \beta_4 \textit{(time to maturity)} + \beta_5 \textit{(index or ETF option dummy)} + \beta_6 \textit{(call or put option dummy)} + \beta_7 \textit{(OTM option dummy)} + \varepsilon \quad (1)$$

4. Empirical Results

We start by examining historical realized daily returns of ETFs and indexes. Table 2 shows summary statistics using closing prices. The average price level and return of ETFs and indexes are very close. The standard deviations of ETFs and their tracking indexes are not significantly different as evident from the performed t-tests. The kurtosis and skewness are similar as well, which suggests no significant difference in the distributions of ETFs and indexes.

Considering non-synchronous ETF prices and index levels at close (Harvey and Whaley, 1991), we also use synchronized prices and index levels[3]. Results are shown in Table 3. Synchronization is performed by obtaining data from NYSE TAQ database, which provides intraday data for traded assets. We keep the last trading price within one second of 4:00pm to create the synchronized dataset. Note that we compute five day rolling standard deviations for the synchronized data, in contrast to monthly standard deviations listed in Table 2. The results in Table 3 are similar to the results in Table 2 in that there is insignificant difference in variance, skewness, and kurtosis between ETFs and indices, which indicates similarity in the distributions of prices of ETFs and indexes.

---

[3] We have no data about returns for the synchronized closing prices, since all used returns use closing prices.

Table 2
Summary Statistics for ETFs and Indexes

DIA	PRICE	priceindx	st dev ETF	st dev INDEX	retDIA	retDJIA
mean	100.3356	100.2354	1.8142	1.7990	0.0003	0.0002
median	103.1000	103.0132	1.6074	1.5359	0.0005	0.0002
st. dev.	8.7456	8.7738	1.0732	1.0734	0.0117	0.0114
count	1821	1821	87	87	1820	1799
t-test			0.0936		0.3621	
skewness	-0.9129	-0.9104			0.0844	0.0640
kurtosis	0.0095	0.0030			3.1200	3.0324
SPY	PRICE	priceindx	st dev ETF	st dev INDEX	retSPY	sprtrn
mean	117.8984	117.5955	2.1888	2.1606	0.0002	0.0001
median	117.6200	117.4415	1.9312	1.8744	0.0006	0.0004
st. dev.	16.7295	16.7876	1.1678	1.1755	0.0115	0.0113
count	1824	1824	87	87	2011	2011
t-test			0.1588		0.1665	
skewness	-0.0932	-0.0969			0.1832	0.1716
kurtosis	-0.5375	-0.5477			2.2398	2.3142
QQQQ	PRICE	priceindx	st dev ETF	st dev INDEX	retQQQQ	retNDX
mean	57.0247	57.2398	2.7400	2.7397	-0.0001	-0.0001
median	38	38.3805	1.1691	1.1639	0.0007	0.0009
st. dev.	41.0745	41.0434	6.1515	6.1470	0.0275	0.0270
count	1715	1715	82	82	1714	1714
t-test			0.0003		0.0335	
skewness	1.8672	1.8694			-3.6212	-3.7600
kurtosis	3.1462	3.1624			76.6752	78.6783

Notes: This table shows the closing price, return and volatility of ETFs and Indexes. Data for DIA and SPY are from 10/01/1998 until 12/30/2005, and for QQQQ from 03/10/1999 until 12/30/2005. The standard deviation is computed monthly.

Since no significant difference in the return (or price) distribution of ETFs and indexes is detected we proceed by examining the implied volatility level of ETFs and indexes. Table 4 presents the mean and median of the implied volatility of each moneyness category. First, we find that the at-the-money implied volatility is significantly lower for SPY and QQQQ than for their tracking indexes – S&P 500 and NASDAQ 100; while the at-the-money implied volatility is significantly higher for DIA compared to DJX. These differential implied volatility levels prompt us to investigate the shape of the implied volatility function.

Figure 1 presents the volatility smiles for the pairs of ETFs and indexes. For deep out-of-the-money calls (or in-the-money puts), ETF options have consistently higher implied volatilities than index options. For deep out-of-money puts (or in-the-money calls), SPY and QQQQ have lower implied volatilities than their tracking indexes. DJX and DIA exhibit similar smile patterns but DIA has a slightly more pronounced smile pattern than the DJX. Since the underlying indexes' and ETFs' return distributions are similar we then examine whether the implied volatility function is related to other factors, e.g. the demand for options.

Table 3
Summary Statistics Using Synchronized Prices

DIA	PRICE	priceindx	st dev ETF	st dev INDEX
mean	102.4500	102.3786	0.8956	0.8951
median	104.5700	104.5130	0.7648	0.7701
st. dev.	9.2394	9.2809	0.5515	0.5481
count	1988	1988	1984	1984
t-test			0.0296	
skewness	-0.7034	-0.6951	1.9032	1.9558
kurtosis	0.4662	0.4543	6.0431	6.3509
SPY	PRICE	priceindx	st dev ETF	st dev INDEX
mean	119.7291	119.4518	1.1074	1.0981
median	120.7100	120.4290	0.9473	0.9342
st. dev.	16.5178	16.5818	0.6884	0.6809
count	1993	1993	1989	1989
t-test			0.4281	
skewness	-0.3214	-0.3241	1.7059	1.7150
kurtosis	-0.4753	-0.4905	4.8620	4.8252
QQQQ	PRICE	priceindx	st dev ETF	st dev INDEX
mean	57.0128	57.2302	1.3059	1.3195
median	37.9600	38.3623	0.6150	0.6278
st. dev.	41.0252	40.9933	2.8818	2.8906
count	1699	1699	1692	1692
t-test			-0.1371	
skewness	1.8672	1.8693	14.9756	14.9712
kurtosis	3.1584	3.1754	275.6903	275.5202

Table 4
Implied Volatility (Restricted Expiration between 7 and 30 days)

		SPY			**SPX**	
Category	N	Mean	Median	N	Mean	Median
1	412	0.2157	0.1898	1237	0.3081	0.1987
2	412	0.1370	0.1349	1234	0.1680	0.1526
3	412	0.1186	0.1163	1234	0.1507	0.1342
4	412	0.1287	0.1105	1232	0.1461	0.1273
5	412	0.2404	0.1460	1203	0.1870	0.1451
		QQQQ			**NDX**	
Category	N	Mean	Median	N	Mean	Median
1	436	0.3082	0.2780	1227	0.3225	0.2763
2	441	0.1791	0.1760	1245	0.2375	0.2245
3	392	0.1607	0.1589	1236	0.2192	0.2030
4	431	0.1594	0.1546	1247	0.2129	0.1921
5	430	0.3745	0.3459	1207	0.2565	0.1984
		DIA			**DJX**	
Category	N	Mean	Median	N	Mean	Median
1	1253	0.2404	0.2233	1216	0.2189	0.2018
2	1254	0.1727	0.1538	1248	0.1624	0.1440
3	1253	0.1530	0.1344	1241	0.1476	0.1281
4	1250	0.1565	0.1368	1248	0.1462	0.1256
5	1230	0.2346	0.1945	1210	0.2030	0.1816

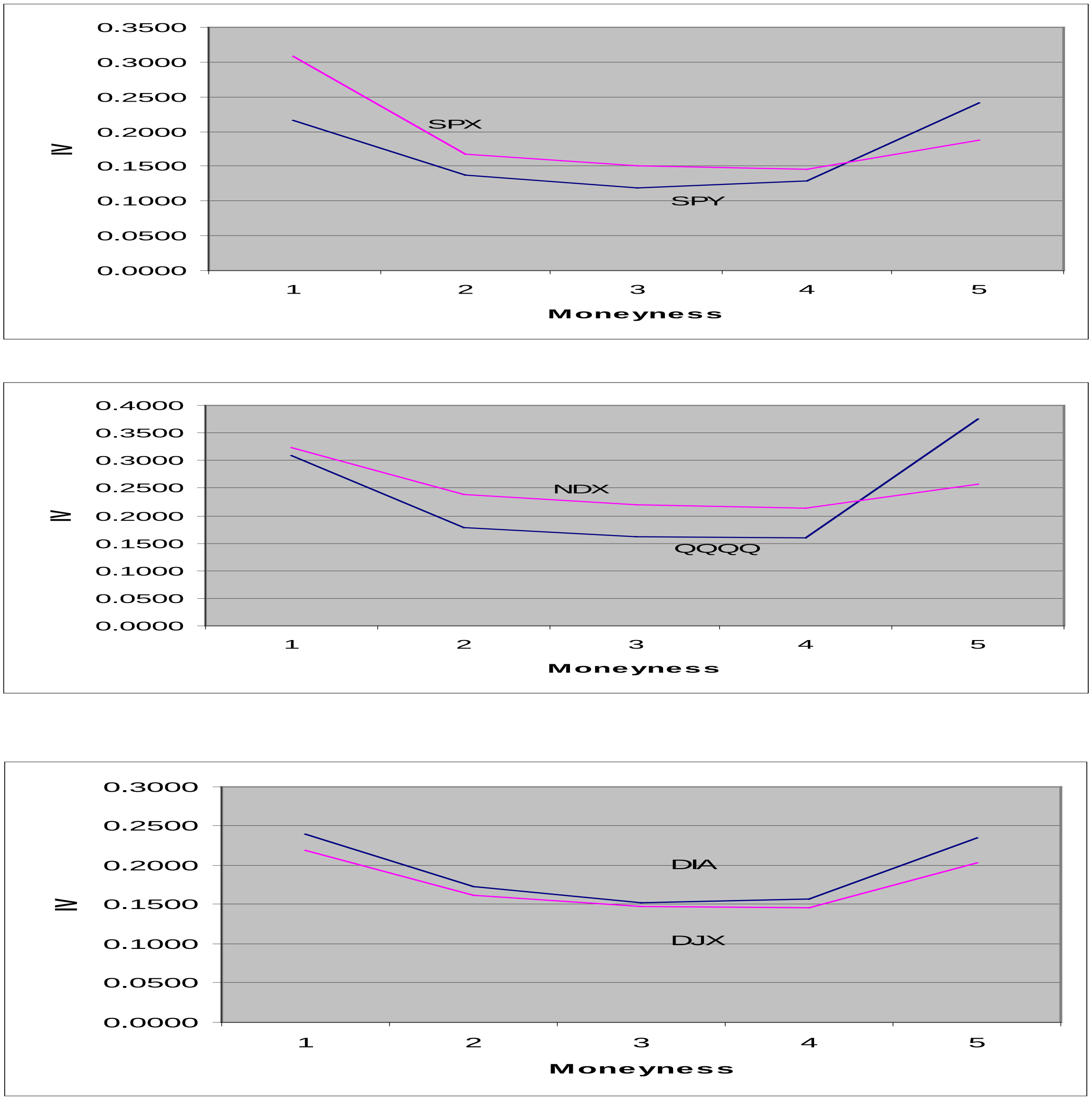

Fig. 1 The Implied Volatility Smile For Spiders, Diamonds and Cubes' Options and Their Respective Index Options.

Table 5 presents mean and median open interest for each moneyness category. Out-of-the-money puts are cheap instruments for hedging while out-of-the-money calls are very attractive for speculation. Table 6 reports two calculations of put-call ratios used to examine the use of options. The first type of put-call ratio is the sum of open interest of puts for the five categories of moneyness divided by the sum of open interest for calls of the five categories of moneyness. The second put-call ratio is computed by only using out-of-the-money and deep out-of-the-money options. Table 6 shows that there is consistently more open interest in puts for all underliers, consistent with facts that more investors use index put options to hedge against market downturns. For ETFs, SPY and DIA options have larger put-call ratios than their tracking indexes (the opposite is true for QQQQ) which suggests that SPY and DIA options are even more widely used for hedging than index options. Alternatively, this also suggests that SPY and DIA are more often used for hedging while QQQQ is more often used for speculation.

Table 5
Open Interest

Panel A. Open Interest of Put Options

	SPY			SPX		
Category	N	Mean	Median	N	Mean	Median
1	206	127157.74	101410.50	620	232237.90	192385.00
2	206	147289.33	149754.50	617	111783.52	96029.00
3	206	78426.91	63140.50	617	54059.56	43067.00
4	206	49754.23	36062.00	616	29936.70	16895.00
5	206	14007.82	4459.00	596	13756.34	4298.50
	QQQQ			**NDX**		
Category	N	Mean	Median	N	Mean	Median
1	225	473633.71	451067.00	626	50811.75	34816.50
2	224	328046.75	297843.00	625	12207.96	8104.00
3	194	217121.15	216742.50	621	3946.36	3459.00
4	214	142278.97	119466.00	622	2940.43	1615.00
5	205	51359.91	28230.00	582	1198.43	271.00
	DIA			**DJX**		
Category	N	Mean	Median	N	Mean	Median
1	627	31547.01	24513.00	626	33724.84	26546.00
2	627	32457.33	28024.00	626	28248.34	23792.00
3	627	16829.42	13914.00	623	17689.95	14863.00
4	626	12085.87	8966.00	624	12853.66	9728.50
5	603	3137.19	904.00	585	4585.95	965.00

Panel B. Open Interest of Call Options

	SPY			SPX		
Category	N	Mean	Median	N	Mean	Median
1	206	37902.94	27701.00	617	39763.05	16972.00
2	206	55856.09	48639.50	617	60530.83	40346.00
3	206	52502.21	46606.00	617	52144.52	38969.00
4	206	54510.21	50788.00	616	62866.33	54387.50
5	206	45556.36	40525.00	607	76408.24	62641.00
	QQQQ			**NDX**		
Category	N	Mean	Median	N	Mean	Median
1	211	133624.25	82498.00	601	3113.27	1007.00
2	217	141441.40	136494.00	620	4880.31	2731.50
3	198	158950.03	147526.00	615	4271.72	3195.00
4	217	184525.05	171455.00	625	8256.75	5724.00
5	225	184566.08	128287.00	625	17450.30	8628.00
	DIA			**DJX**		
Category	N	Mean	Median	N	Mean	Median
1	626	11234.68	6859.50	590	13327.03	6622.50
2	627	17479.87	15749.00	622	21633.00	17475.00
3	626	16737.91	14881.50	618	19320.69	16644.00
4	624	18262.55	17052.00	624	19922.41	18374.00
5	627	16815.76	12317.00	625	20203.58	14813.00

Table 6
Put-Call Open Interest Ratio

	SPY	SPX
=sum open interest puts/sum open interest calls	1.6914	1.5144
=sum 1 and 2 (OTM) puts/ sum 4 and 5 (OTM) calls	2.7426	2.4701
	QQQQ	**NDX**
=sum open interest puts/sum open interest calls	1.5097	1.8725
=sum 1 and 2 (OTM) puts/ sum 4 and 5 (OTM) calls	2.1720	2.4515
	DIA	**DJX**
=sum open interest puts/sum open interest calls	1.1928	1.0286
=sum 1 and 2 (OTM) puts/ sum 4 and 5 (OTM) calls	1.8246	1.5445

We further conduct regression analysis to examine the relationship between the implied volatility and open interest. Regression results are shown in Table 7. Only results for option categories 1 and 5 are presented[4]. The implied volatility is negatively related to open interest, bid-ask spread and time to expiration. The significant relation between open interest and the implied volatility is consistent with the net buying pressure theory. The negative relation between bid-ask spread and the implied volatility supports the arguments that the volatility smile is related to transaction costs. Also consistent with previous empirical evidence, we find the implied volatility increases as options gets closer to expiration.

For category 1 options, results presented in Panel A show that the implied volatility of deep-out-of-the-money puts are higher for DIA and SPY options than index options, while the opposite is true for QQQQ. These results suggest that DIA and SPY are again more often sought for hedging by investors than index options. Also it seems that when examined alone, investors use more NDX than QQQQ for hedging.

Table 7 Panel B presents results for deep out-of-the-money calls. QQQQ and DIA have higher implied volatilities than their tracking indexes, suggesting that demand for speculation that market will move upward are higher for QQQQ and DIA options compared to index options. But the SPY options are less demanded for speculation relative to SPX options.

Overall, our data indicates that DIA and SPY options appear to be more often used for hedging relative to their underlying indexes options, while QQQQ options are more often used for speculation relative to the underlying index NDX option. The reason that we observe such a consistent inverse behavior of the QQQQ might be due to the more active market in the use of QQQQ options relative to the index options. Alternatively, it might be because of the high technology nature of the underlying index which makes it more volatile and useful to speculators, as suggested by Moran (2003).

5. Conclusion

In this paper we study a popular investment vehicle that has achieved prominence- the Exchange Traded Funds. The options on ETFs are a recent development and as such have not been extensively studied. We examine the volatility of ETFs relative to their tracking indexes, which has a significant meaning for risk diversification. We

[4] Results for other categories will be provided at request.

also investigate whether ETF options are just an alternative to index options or they produce new investment opportunity.

Table 7

Regression Results on the Implied Volatility

Panel A: Category 1, DITM call, DOTM put

	SPY and SPX		QQQQ and NDX		DIA and DJX	
call	Adj R-Sq	0.4672	Adj R-Sq	0.2789	Adj R-Sq	0.3661
variable	estimate	p-value	estimate	p-value	estimate	p-value
Intercept	0.6543	<.0001	1.0157	<.0001	0.5469	<.0001
opint	-5.7604	<.0001	-2.6094	<.0001	-8.7845	<.0001
bidask	-8.084	<.0001	-6.9116	<.0001	-3.2797	<.0001
expirationtime	-0.0095	<.0001	-0.0168	<.0001	-0.0076	<.0001
dummyIndex	-0.0083	0.0034	-0.0303	0.0002	0.0015	0.6176
interact	5.301	<.0001	-42.0436	<.0001	4.0488	<.0001
put	Adj R-Sq	0.0704	Adj R-Sq	0.2411	Adj R-Sq	0.0593
Intercept	1.6979	<.0001	0.2176	<.0001	0.2176	<.0001
opint	-5.032	<.0001	-0.2636	<.0001	-2.0138	<.0001
bidask	-1.8477	<.0001	0.1456	<.0001	0.0641	<.0001
expirationtime	-0.0236	<.0001	-0.0017	<.0001	-0.0009	<.0001
dummyIndex	-0.1317	0.002	0.0489	<.0001	-0.0117	<.0001
interact	0.4016	0.7463	-0.7674	<.0001	1.1677	<.0001

Panel B: Category 5, DOTM call, DITM put

	SPY and SPX		QQQQ and NDX		DIA and DJX	
call	Adj R-Sq	0.0978	Adj R-Sq	0.4432	Adj R-Sq	0.0665
variable	estimate	p-value	estimate	p-value	estimate	p-value
Intercept	0.1577	<.0001	0.3354	<.0001	0.2079	<.0001
opint	-0.3455	<.0001	-0.756	<.0001	-4.5815	<.0001
bidask	-0.012	<.0001	0.0745	<.0001	0.0246	<.0001
expirationtime	-0.0017	<.0001	-0.0052	<.0001	-0.0023	<.0001
dummyIndex	0.0102	<.0001	-0.0577	<.0001	-0.0179	<.0001
interact	0.0606	0.4945	-0.8895	<.0001	3.8177	<.0001
put	Adj R-Sq	0.5842	Adj R-Sq	0.3398	Adj R-Sq	0.4504
Intercept	0.6584	<.0001	0.9551	<.0001	0.623	<.0001
opint	-3.0279	<.0001	-3.443	<.0001	-10.609	<.0001
bidask	-8.8246	<.0001	-6.8009	<.0001	-4.6315	<.0001
expirationtime	-0.0085	<.0001	-0.013	<.0001	-0.0072	<.0001
dummyIndex	-0.0134	<.0001	-0.0983	<.0001	-0.03	<.0001
interact	4.2659	<.0001	-43.0016	<.0001	9.2036	<.0001

Notes: The time period is from January 2003 to December 2006. Opint is open interest divided by 1,000,000; bidask is ask price minus bid price divided by ask price; expirationtime is expiration date minus current date; DITM is deep-in-the-money, and DOTM is deep-out-of-the-money; dummyIndex is (1) for the index option and (0) for the ETF option; interact is opint multiplied by dummyIndex.

We study realized return distribution characteristics of ETFs and indexes and find no significant difference. Because the option implied volatility is shown to be a better predictor of future volatility than past return volatility, we examine the implied volatility level of ETF options and index options. We document differential implied volatility levels and functions between ETF and index. These differences are related to transaction costs and open interest, the latter relationship is consistent with the net buying pressure argument of Bollen and Whaley (2002).

We find that DIA and SPY options seem to be more often used for hedging relative to their corresponding index options, while QQQQ options are more often used for speculation relative to their underlying index options. Therefore, ETF options expand investment opportunities and are not just mere alternative to index options.

References

Bakshi, Gurdip**,** Nikunj Kapadia, and Dilip Madan, 2003, Stock return characteristics, skew laws, and the differential pricing of individual equity options, *Review of Financial Studies*, 16-1, pp. 101–43.

Bollen, Nicolas P. B., and Robert E. Whaley, 2004, Does net buying pressure affect the shape of implied volatility functions? *The Journal of Finance*, 59-2, pp. 711-753.

Buraschi, Andrea, and Jens Jackwerth, 2001, The price of a smile: hedging and spanning in option markets, *The Review of Financial Studies*, 14-2, pp. 495-527.

Christensen, Bent Jesper and Nagpurnanand R. Prabhala. (1998) The Relation Between Implied and Realized Volatility, *Journal of Financial Economics*, 50-2, pp. 125-150

Day, Theodore E., and Craig M. Lewis, 1988, The behavior of the volatility implicit in the prices of stock index options, *Journal of Financial Economics*, 22-1, pp. 103-122.

Engle, Robert, and Debojyoti Sarkar, 2006, Premiums-discounts and exchange traded funds, *The Journal of Derivatives*, 13-4, pp. 27-45.

Evnine, Jeremy, and Andrew Rudd, 1985, Index options: the early evidence, *The Journal of Finance*, 40-3, pp. 743-756.

Harvey, Campbell R., and Robert E. Whaley, 1991, S&P 100 index option volatility, *The Journal of Finance*, 46-4, pp. 1551-1561.

Lakonishok, Joseph, Inmoo Lee, and Allen M. Poteshman, 2004, Investor behavior and the option market, NBER Working Paper 10264.

Moran, Matthew T., 2003, Managing costs and risks with ETF tools, *Institutional Investor*, pp. 14-27.

Pontiff, Jeffrey, 1997, Excess volatility and closed-end funds, *The American Economic Review*, 87-1, pp. 155-169.

Poterba, James M., and John B. Shoven, 2002, Exchange-traded funds: a new investment option for taxable investors, *The American Economic Review*, 92-2, pp. 422-427.

Stein, Jeremy, 1989, Overreactions in the options market, *The Journal of Finance*, 44- 4, pp. 1011-1023.

Xu, Xinzhong, and Stephen J. Taylor, 1994, The term structure of volatility implied by foreign exchange options, *The Journal of Financial and Quantitative Analysis*, 29-1, pp. 57-74.