THE IMPLIED VOLATILITY OF ETF AND INDEX OPTIONS

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ABSTRACT

We examine the option-implied volatility of the three most liquid ETFs (Diamonds, Spiders, and Cubes) and their respective tracking indices (Dow 30, S&P 500, and NASDAQ 100). We find that volatility smiles for ETF options are more pronounced than for index options, primarily because deep-in-the-money ETF options have considerably higher implied volatility than deep-in-the-money index options. The observed difference in implied volatility is not due to a difference between the realized return distributions of the underlying ETFs and indices. Differences in implied volatility for ETF and index options also do not appear to be explained by discrepancies in net buying pressure, as theorized by Bollen and Whaley (2004).

JEL: G11; G12

KEYWORDS: exchange-traded funds, index options, implied volatility, open interest

INTRODUCTION

In this paper, we study the option-implied volatility of exchange-traded funds (ETFs) and their tracking indices. ETFs are relatively cheap instruments for diversification in terms of direct costs. They have greatly increased in popularity and have become important investment vehicles for both professional and individual investors. The Investment Company Institute (ICI) reports that there were 80 ETFs in 2000 and 359 ETFs in 2006, a 350 percent increase. ETF assets also increased significantly from $65.59 billion in 2000 to $422.55 billion in 2006, an increase of 544 percent for the period. Most of the literature on ETFs focuses on their tracking errors relative to their respective indices. However, very little research has been conducted on ETF volatility.

The paper contributes to the literature in several ways. First, the paper fills the void in the existing literature on the volatility of ETFs, which play an important role in risk diversification. We examine both the realized return volatility and the option-implied volatility – a commonly used estimate of future volatility. We find that the implied volatility of ETF options is different from that of index options, especially for deep-in-the-money options. However, we find no significant difference in the realized return volatilities of ETFs versus their indices. 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 those of their tracking indices. Our results are inconsistent with the argument of Bollen and Whaley (2004) that an option's implied volatility function should be positively related to its net buying pressure. Therefore, the difference in implied volatility functions between ETFs and indices can be attributed to other factors.

The remainder of this paper is organized as follows: The next section examines the related literature and develops the scope of this research study. We then describe our data and methodology and discuss the results of our empirical tests. The final section concludes.

LITERATURE REVIEW AND RESEARCH DEVELOPMENT

In recent years, ETFs have exploded in popularity as investment tools. However, most of the extant literature on ETFs focuses on their tracking error (e.g., Poterba and Shoven, 2002; Engle and Sarkar, 2006). To our knowledge there are no studies on the volatility of ETFs. In a study of the excess volatility characteristics of closed-end funds, Pontiff (1997) finds that closed-end funds are more volatile than their underlying securities. 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 legally resemble open end funds in the sense that new ETF securities can be issued.

ETFs are passive investment vehicles. The ETF manager closely tracks the yield and price of the underlying index by acquiring the stocks in the index. Nevertheless, ETFs do not necessarily mimic their underlying indices perfectly for several reasons. First, the proportions and exact composition of the ETF portfolio might differ slightly from that of the underlying index as the portfolio manager seeks to minimize costs. Second, ETFs accumulate dividends in a non-interest bearing account and distribute accumulated dividends in a lump sum periodically. (Spiders and Cubes distribute dividends quarterly, while Diamonds pay dividends monthly.) Third, ETFs continue trading after hours until 4:15 p.m., while indices are reported at 4:00 p.m. These differences may cause the return of an ETF to deviate from that of its underlying index.

Christensen and Prabhala (1998) show that a stock's future volatility is predicted more reliably by the option-implied volatility than by the stock's past realized volatility. Therefore, we also investigate the implied volatility of the three best-known and most liquid ETFs: Diamonds, Spiders, and Cubes. These ETFs track the yield and price of the Dow Jones Industrial Average (i.e., Dow 30), S&P 500, and NASDAQ 100, respectively. ETFs are traded like stocks, so ETF options can be considered stock options. The existing literature shows that the implied volatility function of stock options is different from that of index options. Bakshi, Kapadia, and Madan (2003) study S&P 100 index options and the 30 largest stocks in the index and find that the index volatility smile (the variation of the implied volatility across strike prices) is 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 the implied volatility functions of ETF and index options differ. We find that ETF options commonly have higher implied volatilities than their indices, especially for deep-in-the-money options.

In view of this result, we examine not only the mean return of ETFs versus their tracking indices, but also the entire return distribution. We focus on the higher moments of return – volatility, skewness, and kurtosis. Using realized daily returns over a period spanning more than six years, we find no significant difference between the return distributions of ETFs and indices. Since ETFs track their underlying indices closely and are not significantly different from their underlying index in the return distributions, this produces a unique sample to explore the implied volatility of stock options versus index options.

Bollen and Whaley (2004) 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 implied volatility is related to the net buying pressure from orders submitted by investors. Bollen and Whaley study both index options and stock options and find that changes in the implied volatility of S&P 500 index options (individual stock options) are most affected by demand for index puts (individual stock calls). They suggest that net buying pressure is related to investor speculative or hedging demand for options. Put options are widely used for downside protection – especially out-of-the-money puts, which are low-cost hedging instruments. Call options provide upside potential; thus, out-of-the-money calls are more likely used for speculation. Therefore, we attempt to determine whether ETF options are used more often for speculative or hedging purposes – a question that, to the best of our knowledge, has not been explored in prior studies. Index options are widely used for hedging purposes (Evnine and Rudd, 1985). While Moran

(2003) suggests that ETFs are also widely used for hedging, the speculative motive for trading cannot be ruled out. We investigate this question by examining the behavior of both calls and puts of varying levels of moneyness. The level of open interest provides some indication of the demand for an option. Therefore, we perform multivariate regressions to determine whether the implied volatility of ETF and index options is related to open interest in the manner suggested by the net buying pressure hypothesis. Our paper is related to studies by Chan, Cheng, and Lung (2004) and Kang and Park (2008). Chan, Cheng, and Lung use the Bollen and Whaley (2004) net buying pressure metric to examine the implied volatilities, premiums, and profits of Hong Kong Hang Seng index options. Kang and Park use the net buying pressure metric to examine the implied volatilities of KOSPI 200 options. In another work, Chan, Cheng, and Lung (2006) study Hang Seng index options during the Asian Financial Crisis and find evidence in support of the net buying pressure hypothesis. We also account for transaction costs. Peña, Rubio, and Serna (1999) use the bid-ask spread as a proxy for transaction costs and find that the spread influences the curvature of the volatility smile.

DATA AND METHODOLOGY

We study three ETFs: Spiders (SPY), Diamonds (DIA), and Cubes (QQQQ after the switch from AMEX to NASDAQ on 12/1/2004, and QQQ before the switch). Data for these ETFs and for the S&P 500 index are obtained from the Center for Research in Security Prices (CRSP). Data for the Dow Jones Industrial Average are obtained from Dow Jones Indices website (http://djindexes.com), and data for the NASDAQ 100 index are obtained from the NASDAQ Indices website (http://dynamic.nasdaq.com). One potential problem with our data is that closing index levels are reported as of 4:00 p.m., while ETFs continue trading until 4:15 p.m. Thus, to align the trading periods, we use the NYSE Trade and Quote (TAQ) database to obtain the last price for each of our ETFs within one second of 4:00 p.m. each day. Our sample period is from 3/10/1999 to 12/29/2006.

We use options data from the Chicago Board Options Exchange (CBOE) from 2003 to 2006 provided by DeltaNeutral.com. Index options for the Dow 30, S&P 500, and NASDAQ 100 are all European and expire on the Saturday following the third Friday of the expiration month. However, the ETF options are American. The data from DeltaNeutral.com includes implied volatilities based on the Black-Scholes option pricing model. While this is correct for index options, which are European, it is incorrect for ETF options, which are American. Thus, we compute a new set of implied volatilities for ETF options based on a 100-step binomial tree model.

The options dataset is 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) The time to expiration must be greater than 7 days and less than 30 days.
b) The option must satisfy the European option boundary conditions, $c < Se^{-\delta T} - Xe^{-rT}$ and $p < Xe^{-rT} - Se^{-\delta T}$.
c) The option must also satisfy the American option boundary conditions, $C < S - X$ and $P < X - S$.
d) The option must not be so deep out of or in the money that exercise is either impossible or absolutely certain; i.e., the absolute value of the option's hedging delta is between 0.02 and 0.98.

After applying these filters, we sort the remaining options in the sample by implied volatility and remove those observations in the top and bottom 1 percent, resulting in a final sample of 87,588 ETF options and 105,679 index options. These criteria ensure that the option prices used in this study are reasonable and help to avoid the problems of thin trading and excessive volatility, which might endanger the soundness of our conclusions. We determine each option's moneyness using the Bollen and Whaley (2004) method based on the options' delta, as shown in Table 1.

Table 1: Bollen and Whaley Classifications of Moneyness Based on Option's Delta

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

This table shows Bollen and Whaley's five moneyness categories.

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

1. ETFs and indices have different return distributions as argued by Bakshi et al. (2003).
2. Demand, as measured by open interest, is different for ETF options and index options.
3. Transaction costs, as measured by the bid-ask spread, are larger for index options than for ETF options.

To determine which of these explanations are best supported by the data, we perform univariate and multivariate tests on the implied volatility function.

EMPIRICAL RESULTS

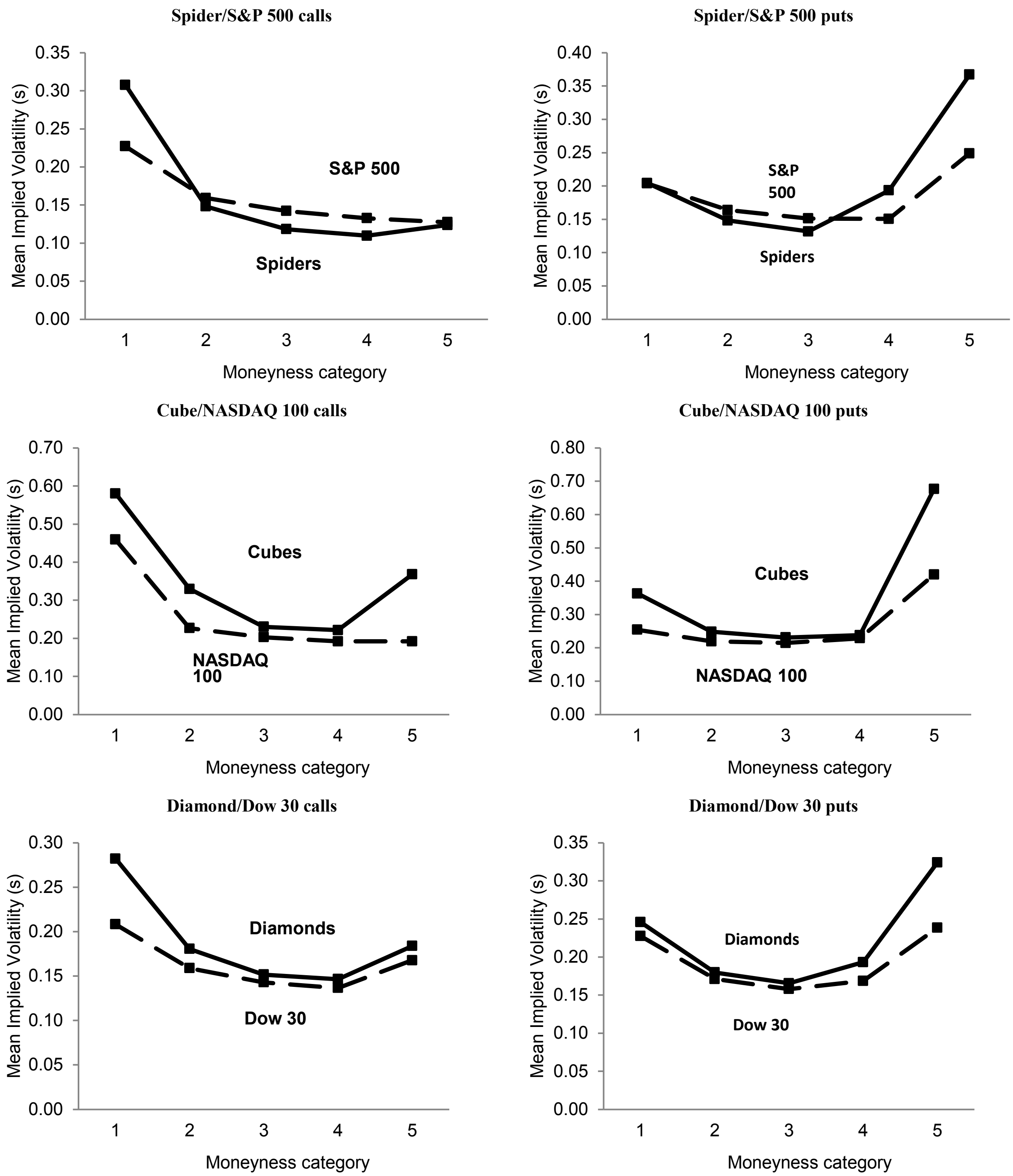
First we examine the implied volatility levels of ETF and index options. Because ETF options are American, we compute their implied volatilities by using a 100-step binomial tree model in lieu of the Black-Scholes formula. Figure 1 presents the mean implied volatility for the ETF and index options in each of the five moneyness categories described previously. Results are presented separately for calls and puts. In each case, ETF options have slightly more pronounced volatility smiles than their corresponding index options. We also note that implied volatilities for Diamond and Cube options are higher in each moneyness category than for Dow 30 and NASDAQ 100 options. For Spider/S&P 500 option pairs, the relative levels of implied volatility depend on the level of moneyness. In every case, DITM ETF options (i.e., Category 1 calls and Category 5 puts) exhibit considerably higher implied volatility than DITM index options, even after using a binomial model to account for potential early exercise of ETF options. For other categories, implied volatility is usually fairly close for ETF vs. index options, but DOTM Cube options do have considerably higher implied volatility than DOTM NASDAQ 100 options.

The documented difference in the implied volatilities of ETF and index options might be due to ETFs and indices having different return distributions, as suggested by Bakshi et al. (2003). Alternatively, the difference may be explained by transaction costs (e.g., bid-ask spreads may be larger for index options compared to ETF options) or by the demand for different types of options, as measured by their open interest.

To address the first of these possible explanations, we begin by examining historical realized daily returns of ETFs and indices. Because Spiders (Cubes) [Diamonds] are designed to be priced at 1/10 (1/40) [1/100] the level of their tracking index, we scale down each index by its appropriate factor to facilitate comparison. Table 2 shows summary statistics using closing prices. The average price level and return of ETFs and indices are very close. The volatility, skewness, and kurtosis are similar as well, which suggests no significant difference in the distributions of ETFs and indices.

In Table 3, we present the same summary statistics using synchronized prices and index levels. Synchronization is performed by obtaining intraday stock price data from the NYSE TAQ database.

Figure 1: Mean Implied Volatilities for ETF and Index Options



This figure shows the Implied Volatility Smiles of the three ETFs versus their tracking indices.

Table 2: Summary Statistics for ETFs and Indices Using Closing Prices

	Spider (SPY) price	1/10 × S&P 500 index level	Spider (SPY) return	S&P 500 index return
Mean	119.6085	119.3234	0.0002	0.0001
Median	120.1350	119.9080	0.0006	0.0004
Standard deviation	16.6891	16.7584	0.0115	0.0113
Skewness	–0.2926	–0.2965	0.1843	0.1686
Kurtosis	–0.5382	–0.5501	2.3392	2.4259
N	1966	1966	1966	1966
	Cube (QQQQ) price	**1/40 × NASDAQ 100 index level**	**Cube (QQQQ) return**	**NASDAQ 100 index return**
Mean	55.2167	54.9418	–0.0000	–0.0001
Median	39.2206	38.7200	0.0007	0.0009
Standard deviation	38.7042	38.7544	0.0259	0.0255
Skewness	2.0920	2.0902	–3.7728	–3.9158
Kurtosis	4.2214	4.2004	84.9578	87.1130
N	1966	1966	1965	1965
	Diamond (DIA) price	**1/100 × Dow 30 index level**	**Diamond (DIA) return**	**Dow 30 index return**
Mean	102.6733	102.5845	0.0003	0.0002
Median	104.6875	104.6693	0.0005	0.0003
Standard deviation	9.2366	9.2876	0.0110	0.0109
Skewness	–0.7532	–0.7467	0.0158	0.0320
Kurtosis	0.5675	0.5568	3.6962	3.5818
N	1963	1963	1962	1962

This table shows the closing prices, volatility, and returns of ETFs and indices. Data are for the period 3/10/1999 until 12/29/2006.

Table 3: Summary Statistics for ETFs and Indices Using Synchronized Prices

	Spider (SPY) price	1/10 × S&P 500 index level	Spider (SPY) return	S&P 500 index return
Mean	119.6081	119.3269	0.0002	0.0001
Median	120.1850	119.9615	0.0004	0.0004
Standard deviation	16.6857	16.7492	0.0114	0.0113
Skewness	–0.2982	–0.3004	0.1541	0.1588
Kurtosis	–0.5287	–0.5434	2.4674	2.3855
N	1948	1948	1947	1947
	Cube (QQQQ) price	**1/40 × NASDAQ 100 index level**	**Cube (QQQQ) return**	**NASDAQ 100 index return**
Mean	54.9223	55.1998	–0.0001	–0.0001
Median	38.6900	39.2070	0.0007	0.0007
Standard deviation	38.6966	38.6456	0.0255	0.0259
Skewness	2.0914	2.0930	–3.9800	–3.8039
Kurtosis	4.2195	4.2414	89.6180	85.3869
N	1949	1949	1948	1948
	Diamond (DIA) price	**1/100 × Dow 30 index level**	**Diamond (DIA) return**	**Dow 30 index return**
Mean	102.6511	102.5772	0.0003	0.0002
Median	104.6700	104.6662	0.0004	0.0003
Standard deviation	9.2419	9.2870	0.0109	0.0109
Skewness	–0.7621	–0.7528	0.0495	0.0142
Kurtosis	0.5818	0.5640	3.5602	3.5510
N	1944	1944	1943	1943

This table shows the synchronized prices, volatility, and returns of ETFs and indices. Data are for the period 3/10/1999 until 12/29/2006.

For each of the three ETFs, the last trading price within one second of 4:00 p.m. is extracted and matched with its closing index level. In rare cases where no ETF price is quoted within one second of 4:00 p.m., that day's observation is deleted from the synchronized dataset. The results in Table 3 are similar to those in Table 2 in that there is no significant difference in volatility, skewness, and kurtosis between ETFs and indices, which again shows similarity in the return distributions of ETFs and indices.

We now test formally for equality between the return distributions of ETFs and their corresponding indices. Table 4 presents Kolmogorov-Smirnov values and significance levels for each of the ETF-index pairs examined in this study. The Kolmogorov-Smirnov test is a non-parametric test based on the maximum distance between the cumulative distribution functions of two random variables. Our results show no significant difference in the distributions of ETF returns and that of their underlying indices, regardless of whether we use closing or synchronized ETF prices. We perform additional tests on the similarity between distributions of ETFs and underlying indices returns with quantile-quantile (Q-Q) plots. In doing so, we observe that ETF and index returns quantiles plot on a straight line against each other, indicating that the two distributions are the same. These plots are not shown but are available upon request. These findings further confirm that our observed differences in implied volatilities are not due to differences between the underlying ETF and index return distributions.

Table 4: Kolmogorov-Smirnov Test for Equality of Distribution Functions

	Using Closing ETF Prices			Using Synchronized ETF Prices		
	KS value	p-value	Decision	KS value	p-value	Decision
Spiders vs. S&P 500	0.0117	0.6536	Fail to reject	0.0049	0.9999	Fail to reject
Cubes vs. NASDAQ 100	0.0079	0.9671	Fail to reject	0.0064	0.9971	Fail to reject
Diamonds vs. Dow 30	0.0079	0.9671	Fail to reject	0.0087	0.9273	Fail to reject

This table shows the Kolmogorov-Smirnov (KS) test results of closing and synchronized ETF and index returns. The test has a null hypothesis of equality between the distribution functions of the two series being compared. Data are for the period 3/10/1999 until 12/29/2006.

We now explore alternative explanations for differences in the implied volatility function. When there are limits to arbitrage, it is possible that implied volatility may be related to the demand for an option, as suggested by Bollen and Whaley's (2004) net buying pressure argument. It is also possible that differences in bid-ask spreads may be partly responsible for different implied volatility levels. To test these two predictions, we estimate the multivariate regression model:

$$\hat{\sigma}_i = \beta_0 + \beta_1 OpInt_i + \beta_2 BidAsk_i + \beta_3 ExpirationTime_i + \beta_4 DummyIndex_i + \beta_5 OpInt * DummyIndex_i + \varepsilon_i, \quad (1)$$

where $\hat{\sigma}$ is the option's implied volatility, *OpInt* is open interest divided by 1,000,000, *BidAsk* is the percentage bid-ask spread (calculated as the dollar spread divided by the ask price), *ExpirationTime* is the amount of time until option expiration, and *DummyIndex* is equal to 1 for index options and 0 for ETF options. Table 5 presents regression results for option categories 1 and 5 (DITM and DOTM options). Results for other categories are not reported but are available from the authors upon request.

Given that open interest is a proxy for demand, we would expect this variable to be positively related to an option's price (and therefore, its implied volatility). However, this is not the case; we document a consistently negative and significant relation between open interest and implied volatility. Therefore, our regression results do not appear to provide evidence for the net buying pressure theory of Bollen and Whaley (2004). The significant relation between the bid-ask spread and implied volatility supports the argument that the volatility smile is related to transaction costs. However, the direction of this relationship is not the same in each case. In general, implied volatility is negatively related to percentage spreads for DITM options, but positively related for DOTM options. The signs and significance levels of the *DummyIndex* coefficients confirm that on average, index options have lower implied volatilities than ETF options. This is especially true for DITM options.

Although we did not obtain the expected sign for the open interest regression variable in Table 5, it is worth noting that open interest is an imperfect proxy for net buying pressure since the level of open interest is affected by both buyer- and seller-initiated trades. Therefore, it is still possible that the demand for different option types may have a nontrivial impact on implied volatilities. It is not surprising that the greatest implied volatility differences are noted for DITM and DOTM options. DOTM options are especially useful for speculators due to the high elasticity of their premium with respect to the underlying asset price or index level. However, DOTM puts and calls can also be useful for hedging by establishing floors on long positions and caps on short positions, respectively. In addition, DITM options can be very useful for establishing delta-neutral hedges; because their gammas are near zero, it is not necessary to adjust the hedge ratio as often when the value of the underlying asset changes. The difference in the implied volatility functions noted in Figure 1 shows that ETF and index options are not perfect substitutes for each other. Although more research is needed in this area, their overall higher implied volatilities suggests that ETF options may be more attractive instruments to hedgers and speculators.

Table 5: Regression Results on the Implied Volatility

Panel A: Category 1 (DITM call, DOTM put)						
	Spider/S&P 500 calls		**Cube/NASDAQ 100 calls**		**Diamond/Dow 30 calls**	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Intercept	0.5840***	<.0001	1.1453***	<.0001	0.4943***	<.0001
OpInt	–5.4610***	<.0001	–3.0671***	<.0001	–8.9034***	<.0001
BidAsk	–6.5819***	<.0001	–7.8635***	<.0001	–2.1254***	<.0001
ExpirationTime	–0.0073***	<.0001	–0.0141***	<.0001	–0.0057***	<.0001
DummyIndex	–0.0384***	<.0001	–0.2199***	<.0001	–0.0605***	<.0001
*OpInt*DummyIndex*	5.1483***	<.0001	–35.3780***	<.0001	5.4452***	<.0001
Adjusted R^2	0.5379		0.2757		0.3725	
Observations	11439		9624		8088	
	Spider/S&P 500 puts		**Cube/NASDAQ 100 puts**		**Diamond/Dow 30 puts**	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Intercept	0.2154***	<.0001	0.3242***	<.0001	0.2066***	<.0001
OpInt	–0.9303***	<.0001	–0.1805***	<.0001	–1.9325***	<.0001
BidAsk	0.0241***	<.0001	0.1267***	<.0001	0.0834***	<.0001
ExpirationTime	–0.0002***	0.0015	–0.0029***	<.0001	–0.0004***	0.0007
DummyIndex	–0.0117***	<.0001	–0.0284***	<.0001	–0.0299***	<.0001
*OpInt*DummyIndex*	0.8439***	<.0001	–0.9001***	<.0001	1.5635***	<.0001
Adjusted R^2	0.0432		0.3580		0.1222	
Observations	11572		8197		10619	
Panel B: Category 5 (DOTM call, DITM put)						
	Spider/S&P 500 calls		**Cube/NASDAQ 100 calls**		**Diamond/Dow 30 calls**	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Intercept	0.1628***	<.0001	0.4688***	<.0001	0.2097***	<.0001
OpInt	–0.4040***	<.0001	–0.9929***	<.0001	–4.3334***	<.0001
BidAsk	–0.0047**	0.0496	0.0692***	<.0001	0.0286***	<.0001
ExpirationTime	–0.0018***	<.0001	–0.0079***	<.0001	–0.0019***	<.0001
DummyIndex	0.0058***	0.0026	–0.1342***	<.0001	–0.0303***	<.0001
*OpInt*DummyIndex*	0.0768	0.3802	–0.8588***	<.0001	3.7567***	<.0001
Adjusted R^2	0.1039		0.4449		0.0772	
Observations	6262		8579		7581	
	Spider/S&P 500 puts		**Cube/NASDAQ 100 puts**		**Diamond/Dow 30 puts**	
	Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Intercept	0.6429***	<.0001	1.0959***	<.0001	0.5777***	<.0001
OpInt	–2.8990***	<.0001	–4.1980***	<.0001	–9.6072***	<.0001
BidAsk	–8.5135***	<.0001	–8.4264***	<.0001	–3.5049***	<.0001
ExpirationTime	–0.0079***	<.0001	–0.0119***	<.0001	–0.0062***	<.0001
DummyIndex	–0.0216***	<.0001	–0.2254***	<.0001	–0.0621***	<.0001
*OpInt*DummyIndex*	4.0745***	<.0001	–34.9441***	<.0001	8.0899***	<.0001
Adjusted R^2	0.6132		0.4037		0.4236	
Observations	12979		14124		7298	

*This table shows regression results based on equation (1). The time period is from January 2003 to December 2006. OpInt is open interest divided by 1,000,000; BidAsk is the dollar bid-ask spread divided by the ask price; ExpirationTime is the amount of time to option expiration; DummyIndex is 1 for index options and 0 for ETF options. *, **, *** indicate significance at the 10, 5, and 1 percent levels respectively.*

CONCLUSION

In this paper we study a popular investment vehicle that has recently grown in prominence, the exchange-traded fund. Options on ETFs are a recent development and as such have not been extensively studied. We document that there is a difference between the implied volatilities of ETF and index options. However, we find no evidence of a difference in the return distributions of ETFs versus their tracking indices, contrary to the predictions of Bakshi et al. (2003).

Because the underlying return distributions are the same, we investigate other possible explanations for differences in the implied volatility functions. We find that implied volatility is related to the percentage bid-ask spread, although the direction of this relationship varies depending on the option's moneyness. We also investigate Bollen and Whaley's (2004) net buying pressure argument. We find that implied volatility is related to open interest (our proxy for option demand), but not in the expected direction. However, given that open interest is an imperfect measure of net buying pressure, we cannot rule out Bollen and Whaley's explanation altogether. Our findings do indicate that ETF options have more pronounced volatility smiles than their equivalent index options. This is driven primarily by the fact that DITM (and, to a lesser extent, DOTM) ETF options have higher implied volatilities. Although the precise reasons for this are still unknown, it is plausible that in some cases ETF options may be more attractive instruments for hedging and speculation. In any event, it is clear that they are not perfect substitutes for index options.

The paper has a natural limitation in the selection of open interest as a proxy for option demand. Option demand could be better measured with the exact net buying pressure variable computed using the Bollen and Whaley procedure, which utilizes intraday option data. However, given that our dataset provides only end-of-day option prices, the computation of the exact net buying pressure metric is not possible at this stage. In a future study, we plan to address this issue after acquiring the intraday option data. Another interesting extension of this paper would be a more detailed examination of Cube options. Cubes switched trading from AMEX to NASDAQ on 12/1/2004, and in a future paper we plan to examine how this change affected the implied volatility of the corresponding ETF and index options.

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