Illiquidity Premia in the Equity Options Market

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Overview of Results

- In the cross-section, illiquid equity options earn higher average returns than do liquid equity options.
- This illiquidity premium is found to be robust across moneyness, and calls/puts as well as across option illiquidity measures and empirical methodologies.
- The effect on option returns of the illiquidity of the underlying stock on option returns is less clear than the effect of option illiquidity.

Brief Literature Review (I)

- Illiquidity premia in stock market:
  - Amihud and Mendelson (1986, 1989), Eleswarapu and Reinganum (1993) Brennan and Subrahmanyam (1996), Jones (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005)…
- … and in bond markets:
  - Amihud and Mendelson (1991), Warga (1992), Boudoukh and Whitelaw (1993), Kamara (1994), Krisnamurthy (2002), Longstaff (2004), Goldreich, Hanke and Nath (2005), Beber, Brandt and Kavajecz (2009).

Brief Literature Review (II)

- Evidence on illiquidity premia in other markets:
  - Deuskar, Gupta and Subrahmanyam (2011) consider interest rate derivatives.
  - Bongarts, de Jong and Driessen (2010) consider the CDS market.
- Equity options
  - Vijh (1990) examine CBOE option market dept and bid-ask spread.
  - George and Longstaff (1993) examine spreads in index options.
- We study the relationship between illiquidity and expected equity option returns.

Option Return Lessons from Black-Scholes

- The Black-Scholes option price level can be written as

$$O = BS\left(S, K, r, T, \sigma\right)$$

- The expected instantaneous option return can be derived as

$$E\left[R^O\right] = \left(r + \left(E\left[R^S\right] - r\right)\frac{S}{O}\frac{\partial O}{\partial S}\right) dt$$

- Note: delta and option leverage

Use BS Delta to Adjust Option Returns for Underlying Stock Returns

- For daily option return we clean out the effects from expected stock returns using the Black-Scholes delta for each option

$$\tilde{R}^{O}_{t+1,n} = R^{O}_{t+1,n} - R^{S}_{t+1} S_t \frac{\Delta_{t,n}}{O_{t,n}}$$

- Where *O* is the midpoint quote and *n* refers to a particular option on a given firm.
- Results are robust when using regression-based option return adjustments.

Computing Option Returns

- For each of 3 moneyness categories, we compute daily (and weekly) option returns for a given firm using

$$\tilde{R}^{O}_{t+1} = \frac{1}{N}\sum_{n=1}^{N} \frac{O_{t+1}(K_n, T_n - 1) - O_t(K_n, T_n)}{O_t(K_n, T_n)} - R^{S}_{t+1} S_t \frac{1}{N}\sum_{n=1}^{N} \frac{\Delta_t(K_n, T_n)}{O_t(K_n, T_n)}$$

- OptionMetrics. End of day quotes.
- We use all available S&P500 firms.

Weekly Returns

- For weekly returns we rebalance daily

$$\tilde{R}^{O}_{t:t+5} = R^{O}_{t:t+5} - \sum_{j=1}^{5} \frac{R^{S}_{t+j} S_{t+j-1} \Delta_{t+j-1}}{O_t}.$$

- We use 3 moneyness categories: ITM, ATM and OTM defined using the BS delta. We also report results for all strikes together.
- We study calls and puts separately

Data Filters

We eliminate the following contracts:

(i) Prices that violate no-arbitrage conditions

(ii) Observations with ask price lower than or equal to the bid price

(iii) Options with an open interest or volume of zero

(iv) Options with missing prices, implied volatilities or deltas

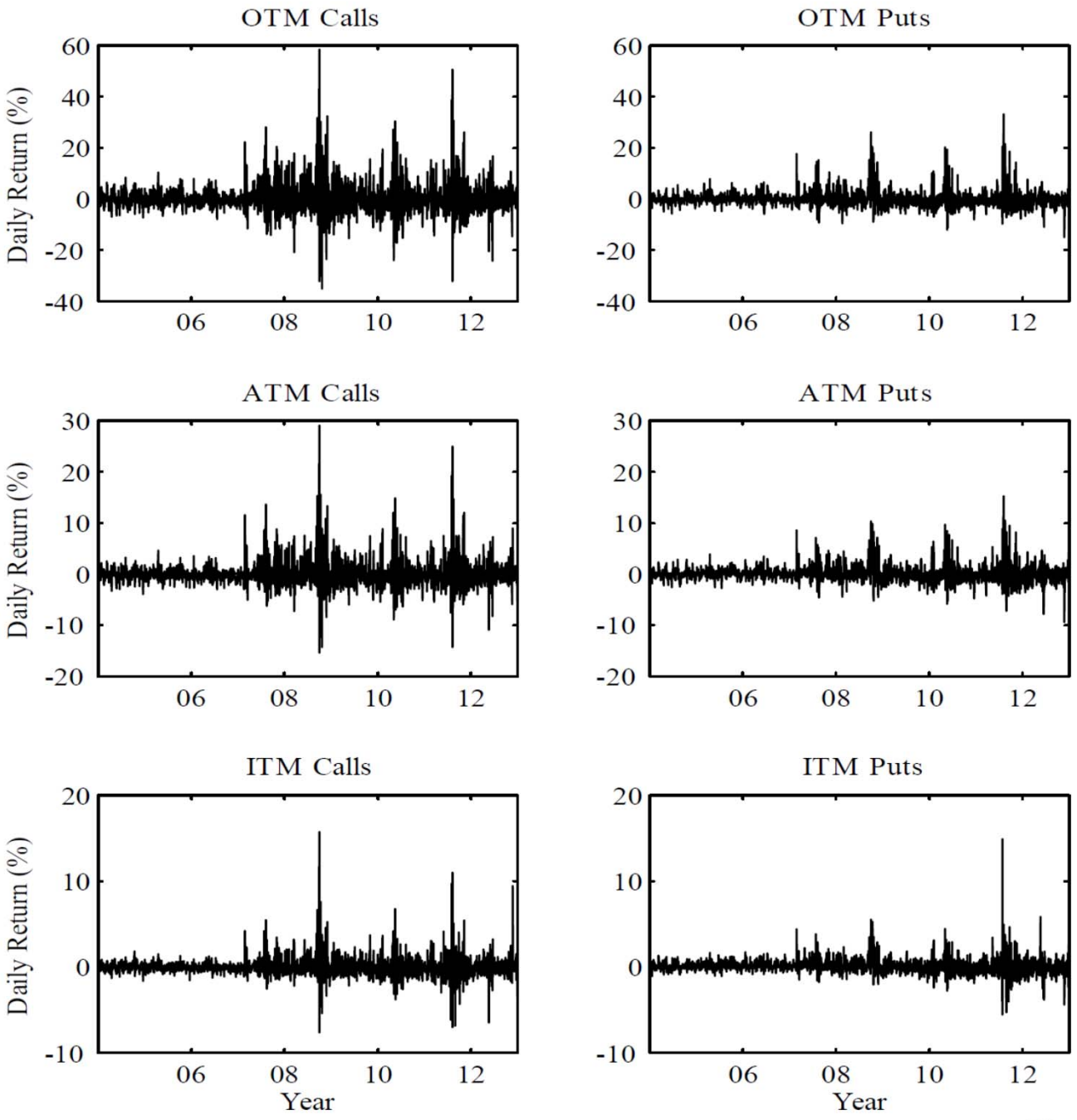
(v) Options where the bid-ask spread is lower than the minimum tick size which signals a data error

Average Delta-Hedged Daily Option Returns

OTM Calls & Puts

ATM Calls & Puts

ITM Calls & Puts



Descriptive Statistics for Avearge Daily and Weekly Delta-Hedged Option Returns. Calls and Puts.

	OTM	ATM	ITM	ALL	OTM	ATM	ITM	ALL
	Panel A.1 Daily Delta-Hedged Returns for Calls				**Panel A.2 Daily Delta-Hedged Returns for Puts**			
Mean	0.26	0.05	0.09	0.05	0.30	0.13	0.25	0.12
Stdev	14.29	6.39	3.44	7.49	9.81	5.28	3.43	6.18
Skew	3.11	2.72	2.80	3.58	3.77	3.04	2.90	4.42
Kurt	57.97	55.48	64.74	87.73	74.28	57.89	53.00	99.75
ρ(1)	-0.07	-0.07	-0.10	-0.10	-0.01	-0.02	-0.05	-0.03
abs [ρ(1)]	0.14	0.15	0.17	0.20	0.12	0.11	0.11	0.14
Av. # obs	993	1072	918	1345	941	902	654	1216
Av. # firms	313	339	290	425	296	285	205	384
	OTM	**ATM**	**ITM**	**ALL**	**OTM**	**ATM**	**ITM**	**ALL**
	Panel B.1 Weekly Delta-Hedged Returns for Calls				**Panel B.2 Weekly Delta-Hedged Returns for Puts**			
Mean	0.34	-0.09	-0.01	-0.02	0.15	0.09	0.27	-0.04
Stdev	26.52	11.45	5.18	13.33	19.83	9.68	5.35	11.36
Skew	2.16	1.88	1.96	2.32	2.59	1.83	1.62	2.57
Kurt	19.11	17.83	19.70	23.67	24.18	17.07	14.82	25.84
ρ(1)	0.00	0.02	0.00	0.01	0.06	0.03	-0.01	0.04
abs [ρ(1)]	0.06	0.08	0.07	0.11	0.06	0.06	0.04	0.07
Av. # obs	231	241	215	297	216	210	164	272
Av. # firms	346	361	322	446	321	311	240	407

Computing Option Illiquidity (I)

- LiveVol is a new commercial data base with intraday equity option trades and matched quotes. Starts in 2004.
- We compute the daily relative effective spread for *each trade on each option on each stock on each day*

$$IL_k^O = \frac{2|P_k - M_k|}{M_k},$$

- Here P_k is the price in the k'th trade and M_k is the midpoint from the consolidated (across exchanges) best bid and ask quotes prevailing at the time of the k'th trade.

Computing Option Illiquidity (II)

- Our option illiquidity measure is now computed *for each option on each stock on each day* by volume-weighting the relative effective spreads across the trades throughout the day:

$$IL^O = \frac{\sum_k Vol_k IL_k^O}{\sum_k Vol_k}$$

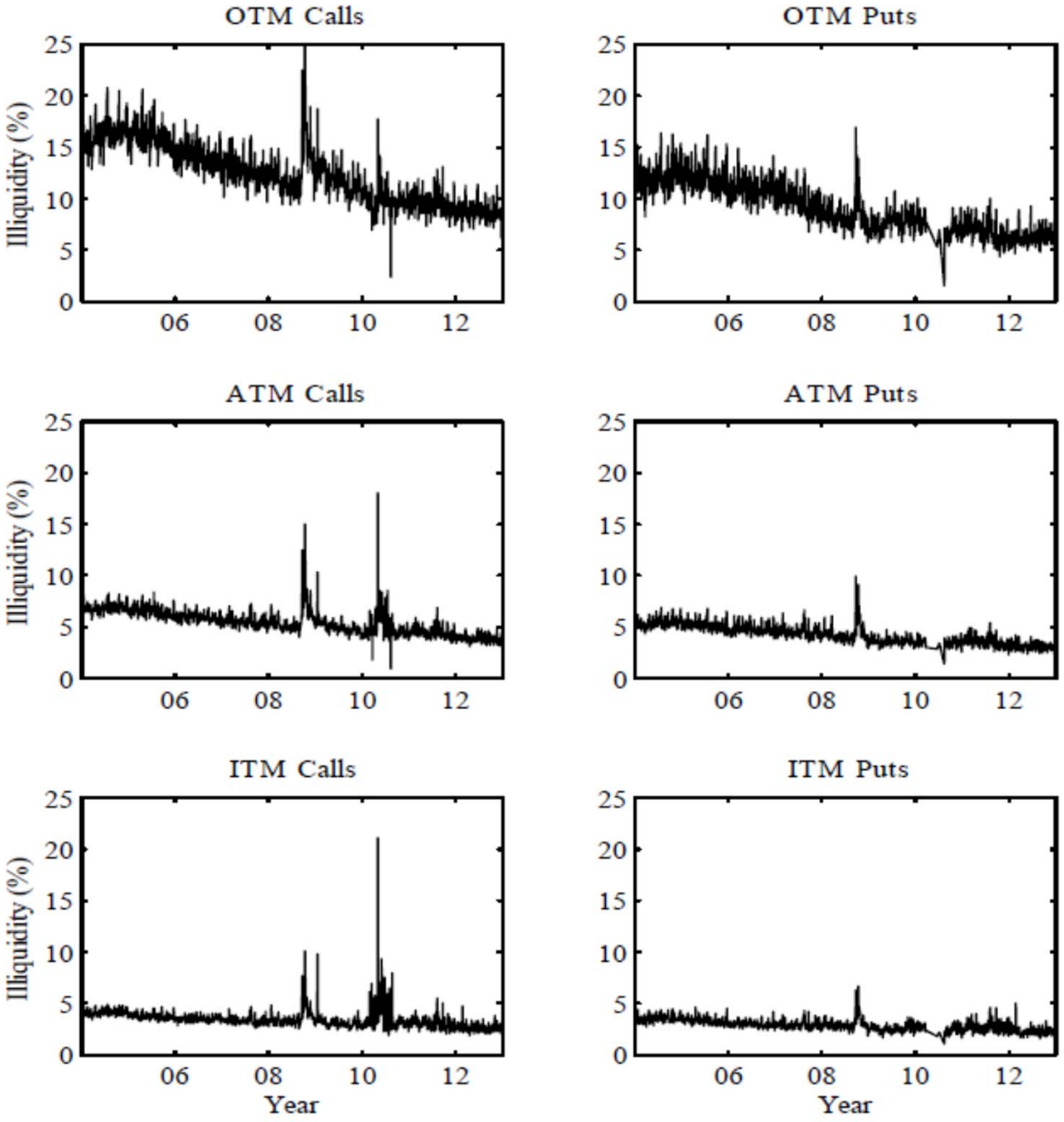
- This is our benchmark option illiquidity measure. We will consider alternatives as well.

Option Illiquidity

OTM Calls & Puts

ATM Calls & Puts

ITM Calls & Puts



Computing Stock Illiquidity

- We again use the TAQ **effective** spread for the k'th intraday trade

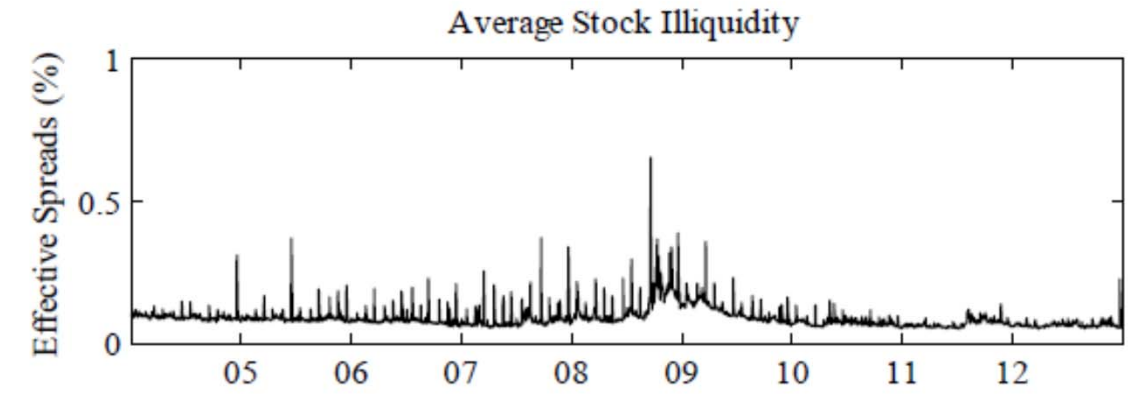
$$IL_k^S = \frac{2|P_k - M_k|}{M_k},$$

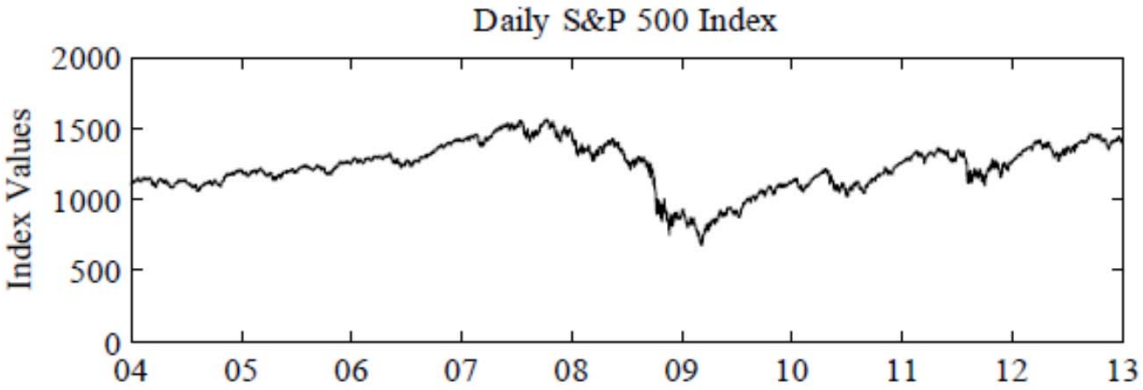
where P_k is the price of the k'th trade and M_k is the midpoint of the best bid/ask at the time.

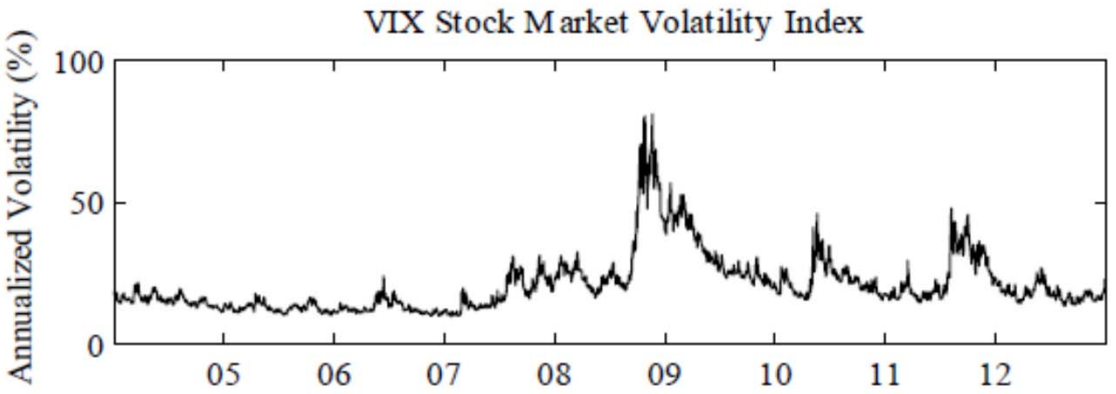
- We again compute the daily dollar-volume weighted average

$$IL^S = \frac{\sum_k DolVol_k IL_k^S}{\sum_k DolVol_k}$$

- Average Stock Illiquidity
- S&P500 Level
- CBOE VIX







Descriptive Statistics for Illiquidity Measures

Panel A. Descriptive Statistics

	Options				Stocks
	OTM	ATM	ITM	ALL	
	IL^O Call **Options**				IL^S
Mean	14.81	6.74	4.41	9.80	0.22
Std	10.40	4.84	3.71	7.48	0.16
Min	0.23	0.13	0.07	0.33	0.05
Max	95.97	57.52	47.52	76.40	2.60
ρ(1)	0.30	0.30	0.21	0.28	0.44
	IL^O Put **Options**				
Mean	11.51	5.58	4.02	8.22	
Std	8.84	4.20	3.48	6.75	
Min	0.17	0.11	0.05	0.17	
Max	81.64	44.27	38.87	69.70	
ρ(1)	0.29	0.27	0.18	0.26	

Average Correlation Across Firms

Panel B. Correlation Matrix, IL^O Call Options

	OTM	ATM	ITM	ALL	StockIlliq
OTM	1.00				
ATM	0.48	1.00			
ITM	0.37	0.40	1.00		
ALL	0.78	0.60	0.43	1.00	
IL^S	0.26	0.27	0.19	0.26	1.00

Panel C. Correlation Matrix, IL^O Put Options

	OTM	ATM	ITM	ALL	StockIlliq
OTM	1.00				
ATM	0.45	1.00			
ITM	0.33	0.35	1.00		
ALL	0.79	0.57	0.41	1.00	
IL^S	0.22	0.20	0.13	0.21	1.00

Portfolio Sorting Results

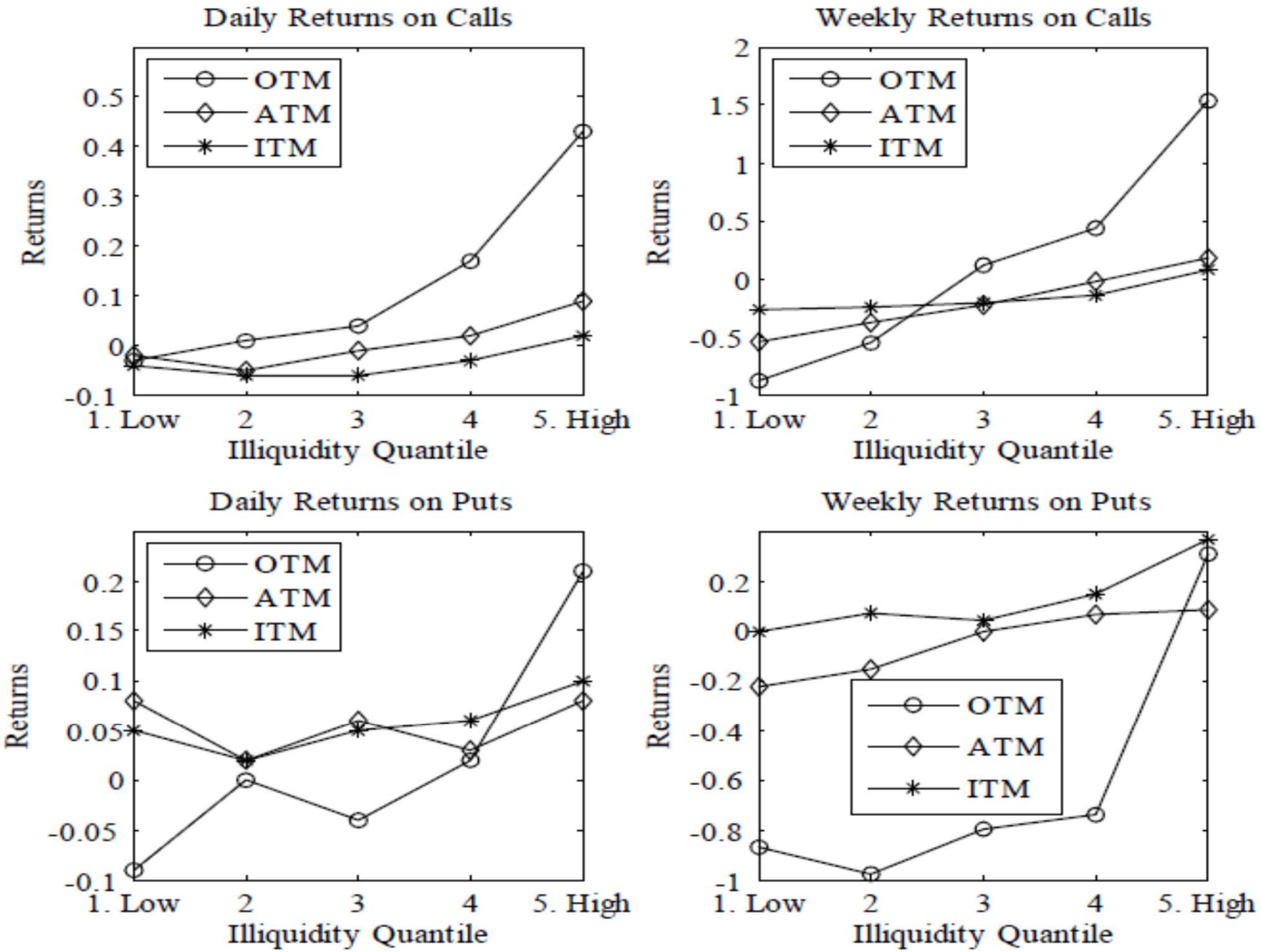
- First: Single Sort. *Sort firms* into lagged (skip one day) option illiquidity portfolio baskets and investigate the patterns of corresponding option portfolio means and alphas (Carhart four factors).
- Second: Sequential Double Sort: *Sort firms* first on lagged option illiquidity and then on lagged stock illiquidity.
- In each moneyness category we compute equal-weighted average returns for different options on the same firm to get one observation per firm per category each day. Volume and open-interest weighted returns yield qualitatively very similar results.

Single Sort on Option Illiquidity. Daily Returns

		CALL Options						PUT Options					
		1	2	3	4	5	5-1	1	2	3	4	5	5-1
OTM	mean	-0.03	0.01	0.04	0.17	0.43	0.46	-0.09	0.00	-0.04	0.02	0.21	0.30
	alpha	0.05	0.08	0.12	0.25	0.53	0.48	-0.07	0.02	-0.03	0.03	0.21	0.28
	t-stat	0.52	0.88	1.24	2.72	5.07	7.21	-0.77	0.20	-0.29	0.32	1.96	5.42
ATM	mean	-0.02	-0.05	-0.01	0.02	0.09	0.11	0.08	0.02	0.06	0.03	0.08	0.00
	alpha	0.01	-0.02	0.01	0.05	0.13	0.12	0.09	0.03	0.07	0.04	0.08	-0.01
	t-stat	0.14	-0.39	0.29	1.03	2.46	3.92	2.23	0.75	1.55	0.85	1.60	-0.37
ITM	mean	-0.04	-0.06	-0.06	-0.03	0.02	0.06	0.05	0.02	0.05	0.06	0.10	0.05
	alpha	-0.03	-0.05	-0.05	-0.01	0.04	0.07	0.06	0.03	0.06	0.06	0.10	0.05
	t-stat	-1.51	-2.35	-2.32	-0.51	1.56	3.83	2.27	1.33	1.81	2.67	3.77	1.76
ALL	mean	-0.07	-0.07	-0.03	-0.01	0.14	0.21	-0.04	-0.03	-0.01	0.03	0.11	0.15
	alpha	-0.04	-0.03	0.01	0.03	0.19	0.23	-0.02	-0.01	0.00	0.03	0.11	0.13
	t-stat	-0.92	-0.66	0.22	0.57	3.37	6.45	-0.54	-0.28	-0.03	0.57	1.60	3.51

Single Sort on Option Illiquidity. Weekly Returns

		CALL Options						PUT Options					
		1	2	3	4	5	5-1	1	2	3	4	5	5-1
OTM	mean	-0.87	-0.55	0.12	0.44	1.54	2.41	-0.87	-0.98	-0.80	-0.74	0.31	1.18
	alpha	-0.55	-0.21	0.44	0.77	1.89	2.44	-0.63	-0.74	-0.55	-0.48	0.58	1.21
	t-stat	-1.37	-0.50	1.00	1.62	3.69	8.04	-1.61	-1.66	-1.13	-0.92	0.91	3.43
ATM	mean	-0.54	-0.37	-0.22	-0.02	0.18	0.72	-0.22	-0.15	0.00	0.07	0.09	0.31
	alpha	-0.41	-0.24	-0.09	0.12	0.32	0.73	-0.09	-0.02	0.14	0.22	0.22	0.31
	t-stat	-2.10	-1.14	-0.44	0.51	1.25	5.74	-0.52	-0.12	0.66	0.88	0.92	2.61
ITM	mean	-0.26	-0.24	-0.20	-0.14	0.08	0.34	0.00	0.07	0.04	0.15	0.37	0.37
	alpha	-0.22	-0.20	-0.16	-0.09	0.13	0.35	0.06	0.13	0.10	0.21	0.44	0.39
	t-stat	-2.52	-2.25	-1.69	-0.83	1.15	4.82	0.78	1.65	1.14	2.35	3.97	5.82
ALL	mean	-0.46	-0.38	-0.35	0.06	0.44	0.91	-0.49	-0.47	-0.40	-0.28	0.27	0.76
	alpha	-0.33	-0.22	-0.19	0.24	0.63	0.96	-0.36	-0.33	-0.25	-0.13	0.43	0.79
	t-stat	-1.71	-1.02	-0.82	0.89	2.20	5.52	-2.02	-1.47	-0.89	-0.46	1.19	3.20


Daily Returns on Calls
OTM
ATM
ITM
Returns
0.5
0.4
0.3
0.2
0.1
0
-0.1
1. Low
2
3
4
5. High
Illiquidity Quantile
Weekly Returns on Calls
OTM
ATM
ITM
Returns
2
1.5
1
0.5
0
-0.5
-1
1. Low
2
3
4
5. High
Illiquidity Quantile
Daily Returns on Puts
OTM
ATM
ITM
Returns
0.2
0.15
0.1
0.05
0
-0.05
-0.1
1. Low
2
3
4
5. High
Illiquidity Quantile
Weekly Returns on Puts
OTM
ATM
ITM
Returns
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1. Low
2
3
4
5. High
Illiquidity Quantile

Sequential Sorts. Alphas. Calls. Daily

		1.ILS	2	3	4	5.ILS	5-1	t-stat
OTM	**1.ILO**	0.06	0.04	-0.03	0.07	0.09	0.03	0.30
	2	-0.10	0.06	0.17	0.13	0.12	0.22	1.70
	3	-0.03	0.09	0.08	0.13	0.31	0.34	1.74
	4	0.16	0.19	0.22	0.39	0.25	0.09	0.84
	5.ILO	0.59	0.54	0.39	0.61	0.56	-0.03	-0.18
	5-1	0.53	0.50	0.42	0.53	0.47		
	t-stat	4.14	2.95	4.10	4.61	4.04		
ATM	**1.ILO**	0.00	0.03	-0.04	0.01	0.04	0.05	1.18
	2	-0.04	-0.06	0.00	-0.03	0.03	0.07	1.66
	3	-0.02	-0.05	0.01	0.06	0.05	0.07	1.57
	4	0.08	0.07	0.08	0.03	0.01	-0.07	-1.20
	5.ILO	0.08	0.18	0.07	0.19	0.13	0.06	0.77
	5-1	0.08	0.15	0.11	0.19	0.09		
	t-stat	1.39	2.56	2.34	2.90	1.70		
ITM	**1.ILO**	0.00	-0.03	-0.04	-0.08	0.00	0.00	0.18
	2	-0.03	-0.07	-0.05	-0.02	-0.05	-0.01	-0.56
	3	-0.06	-0.04	-0.08	-0.04	-0.03	0.02	0.85
	4	-0.05	-0.01	0.00	-0.02	0.01	0.06	1.53
	5.ILO	0.06	0.04	0.02	0.05	0.03	-0.03	-0.75
	5-1	0.07	0.07	0.06	0.13	0.03		
	t-stat	1.87	1.60	2.22	3.17	0.89		
ALL	**1.ILO**	-0.06	-0.01	-0.06	-0.05	-0.01	0.05	1.30
	2	-0.09	-0.06	0.04	-0.06	0.02	0.12	2.72
	3	-0.05	0.02	0.02	0.02	0.05	0.10	1.71
	4	-0.03	0.00	0.03	0.03	0.15	0.18	2.04
	5.ILO	0.25	0.23	0.18	0.13	0.18	-0.06	-0.77
	5-1	0.31	0.24	0.24	0.18	0.19		
	t-stat	4.57	3.96	4.17	3.24	3.00		

Sequential Sorts. Alphas. Puts. Daily

		1.ILS	2	3	4	5.ILS	5-1	t-stat
OTM	**1.ILO**	-0.11	-0.06	-0.08	-0.12	-0.01	0.10	1.54
	2	-0.02	-0.02	0.05	0.04	0.01	0.03	0.44
	3	-0.17	-0.02	-0.10	0.12	-0.01	0.15	2.04
	4	-0.18	-0.05	0.05	0.21	0.06	0.24	2.82
	5.ILO	0.13	0.04	0.18	0.26	0.38	0.25	2.62
	5-1	0.24	0.11	0.26	0.37	0.39		
	t-stat	2.92	1.36	2.19	4.04	4.90		
ATM	**1.ILO**	0.04	0.12	0.11	0.10	0.08	0.03	0.83
	2	0.01	0.00	0.02	0.03	0.09	0.08	2.33
	3	0.01	0.14	0.04	0.08	0.07	0.07	1.15
	4	-0.07	0.09	0.06	0.12	-0.03	0.04	0.91
	5.ILO	-0.01	0.02	0.16	0.07	0.14	0.15	2.14
	5-1	-0.05	-0.10	0.05	-0.03	0.06		
	t-stat	-0.86	-1.76	0.91	-0.68	1.16		
ITM	**1.ILO**	0.03	0.03	0.05	0.13	0.05	0.02	0.81
	2	0.02	-0.01	0.04	0.02	0.05	0.03	1.12
	3	0.04	0.01	0.10	0.06	0.06	0.02	0.51
	4	-0.02	-0.02	0.15	0.07	0.11	0.13	2.20
	5.ILO	0.03	0.05	0.10	0.12	0.19	0.16	4.37
	5-1	0.00	0.02	0.05	-0.01	0.14		
	t-stat	-0.03	0.52	1.57	-0.09	4.45		
ALL	**1.ILO**	-0.07	-0.04	0.02	-0.08	0.02	0.10	2.68
	2	-0.06	-0.02	-0.03	0.01	0.00	0.07	1.49
	3	-0.06	0.04	-0.01	0.00	0.00	0.07	1.51
	4	-0.08	-0.06	0.14	0.10	0.04	0.12	2.49
	5.ILO	0.10	0.05	0.03	0.18	0.15	0.06	0.95
	5-1	0.17	0.09	0.02	0.26	0.13		
	t-stat	2.89	1.77	0.25	4.28	2.86		

Multivariate Analysis

- We want to control for other confounding effects and so need to switch from sorting to regression analysis.
  - Firm volatility (GARCH)
  - Systematic risk of the stock (square root of R^2 from regression on Carhart 4 factors)
  - Firm size (log of market cap)
  - Firm leverage (long term debt plus preferred stock over market value of equity. Use previous quarter from Compustat)

Firm-Level Expected Option Returns

- On each day (or week) *t* we run the cross-sectional regressions

$$\tilde{R}^{O}_{i,t+1} = \beta_{0,t} + \beta_{1,t} IL^{O}_{i,t-1} + \beta_{2,t} IL^{S}_{i,t-1} + \beta_{3,t} \sigma_{i,t-1}$$

$$+ \beta_{4,t} b_{i,t-1} + \beta_{5,t} \ln(size_{i,t-1}) + \beta_{6,t} lev_{i,t-1} + \varepsilon_{i,t+1}$$

- We skip one day between LHS and RHS
- We then report the time-series average coefficient for firms within each moneyness category.

GARCH Volatility

- We model volatility of each stock using a simple GARCH model

$$
\begin{aligned}
R^S_{i,t} &= \mu_i + \sigma_{i,t-1} z_{i,t} \\
\sigma^2_{i,t} &= \alpha_{0,i} + \alpha_{1,i}\sigma^2_{i,t-1} + \alpha_{2,i}\sigma^2_{i,t-1} z^2_{i,t-1}
\end{aligned}
$$

- Where z is a standard normal iid innovation.

Regressions on Daily Option Returns. Calls

	OTM		**ATM**		**ITM**		**ALL**	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
IL^O	0.017	5.50	0.010	3.69	0.007	3.10	0.012	5.46
IL^S	-1.326	-1.78	-0.645	-1.59	-0.173	-0.67	-0.784	-2.24
σ	-0.003	-1.50	0.001	0.94	-0.001	-1.04	0.000	-0.34
b	0.003	1.30	0.003	3.07	0.000	0.63	0.003	2.50
log(Size)	-0.002	-6.16	0.000	-2.44	0.000	-2.78	0.000	-3.37
lev	0.004	3.24	0.002	3.11	0.001	2.49	0.002	2.56
R^2	0.04		0.04		0.04		0.04	
#firms	298		315		270		412	
#cs obs	2118		2118		2055		2118	

Regressions on Weekly Option Returns. Calls

	OTM		**ATM**		**ITM**		**ALL**	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
IL^O	0.094	5.07	0.043	3.49	0.043	2.77	0.048	3.81
IL^S	-12.946	-4.09	-3.685	-3.10	-0.955	-1.42	-4.890	-3.52
σ	0.004	0.41	0.000	-0.03	-0.004	-2.17	0.002	0.48
b	0.023	2.16	0.015	2.89	0.001	0.37	0.014	2.66
log(Size)	-0.006	-4.38	-0.001	-2.43	-0.001	-2.36	-0.002	-2.67
lev	0.006	1.04	0.006	2.27	0.004	2.77	0.005	1.78
R^2	0.04		0.04		0.04		0.03	
#firms	333		347		302		433	
#cs obs	468		468		468		468	

Regressions on Daily Option Returns. Puts

	OTM		**ATM**		**ITM**		**ALL**	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
IL^O	0.016	6.06	0.003	1.04	0.009	2.52	0.010	4.56
IL^S	0.064	0.12	-0.094	-0.24	-0.015	-0.06	0.162	0.41
σ	0.005	2.89	0.003	3.60	0.000	0.31	0.003	3.22
b	0.000	0.11	0.002	1.99	0.000	0.20	0.001	0.66
log(Size)	-0.001	-2.63	0.000	-1.77	0.000	-5.11	0.000	-1.63
lev	-0.001	-0.71	-0.001	-1.65	0.000	-0.86	-0.001	-1.29
R^2	0.04		0.04		0.04		0.04	
#firms	284		270		191		373	
#cs obs	2013		2013		2013		2013	

Regressions on Weekly Option Returns. Puts

	OTM		**ATM**		**ITM**		**ALL**	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
IL^O	0.074	5.32	0.029	1.98	0.064	4.74	0.060	5.26
IL^S	-2.445	-1.53	-0.365	-0.29	-0.613	-0.99	-0.417	-0.42
σ	0.023	2.94	0.007	1.61	0.002	0.97	0.017	3.55
b	-0.002	-0.19	0.009	2.29	0.001	0.64	0.001	0.16
log(Size)	0.000	-0.14	-0.001	-2.63	-0.001	-4.80	0.000	0.98
lev	-0.006	-1.16	-0.003	-1.47	-0.003	-3.07	-0.004	-1.40
R^2	0.04		0.04		0.04		0.04	
#firms	310		300		229		395	
#cs obs	450		450		450		450	

Economic Magnitudes

- The effects of option illiquidity on option returns are large:
- For example, for short-term OTM call options the coefficient on IL^{O} is 0.017 for daily returns.
- The standard deviation of IL^{O} is 10.40% for OTM calls.
- Thus a two-standard-deviation shock to IL^{O} gives a 35 bps increase in expected daily return on the short-term OTM call option.

Exploring the Results

- Alternative option illiquidity measure
- Various robustness checks
- Broader implications of results

Computing Option Illiquidity from Daily Closing Quotes

- Using OptionMetrics data we take the daily relative **quoted** spread for each option

$$IL^{O}_{t,n} = \frac{OA_t(K_n, T_n) - OB_t(K_n, T_n)}{O_t(K_n, T_n)}$$

- ..and average it across options within each moneyness category

$$IL^{O}_{t} = \frac{1}{N} \sum_{n=1}^{N} IL^{O}_{t,n}$$

Relative Quoted Spread Sorts. Daily Returns

		CALL Options						PUT Options					
		1	2	3	4	5	5-1	1	2	3	4	5	5-1
OTM	mean	-0.03	0.01	0.04	0.17	0.43	0.46	-0.09	0.00	-0.04	0.02	0.21	0.30
	alpha	0.05	0.08	0.12	0.25	0.53	0.48	-0.07	0.02	-0.03	0.03	0.21	0.28
	t-stat	0.52	0.88	1.24	2.72	5.07	7.21	-0.77	0.20	-0.29	0.32	1.96	5.42
ATM	mean	-0.02	-0.05	-0.01	0.02	0.09	0.11	0.08	0.02	0.06	0.03	0.08	0.00
	alpha	0.01	-0.02	0.01	0.05	0.13	0.12	0.09	0.03	0.07	0.04	0.08	-0.01
	t-stat	0.14	-0.39	0.29	1.03	2.46	3.92	2.23	0.75	1.55	0.85	1.60	-0.37
ITM	mean	-0.04	-0.06	-0.06	-0.03	0.02	0.06	0.05	0.02	0.05	0.06	0.10	0.05
	alpha	-0.03	-0.05	-0.05	-0.01	0.04	0.07	0.06	0.03	0.06	0.06	0.10	0.05
	t-stat	-1.51	-2.35	-2.32	-0.51	1.56	3.83	2.27	1.33	1.81	2.67	3.77	1.76
ALL	mean	-0.07	-0.07	-0.03	-0.01	0.14	0.21	-0.04	-0.03	-0.01	0.03	0.11	0.15
	alpha	-0.04	-0.03	0.01	0.03	0.19	0.23	-0.02	-0.01	0.00	0.03	0.11	0.13
	t-stat	-0.92	-0.66	0.22	0.57	3.37	6.45	-0.54	-0.28	-0.03	0.57	1.60	3.51

Relative Quoted Spread Sorts. Weekly Returns

		CALL OPTION						PUT OPTIONS					
		1	2	3	4	5	5-1	1	2	3	4	5	5-1
OTM	mean	-0.57	-0.44	-0.37	-0.02	1.19	1.75	-0.49	-0.59	-0.55	-0.66	0.78	1.26
	alpha	-0.24	-0.07	0.01	0.38	1.62	1.86	-0.28	-0.36	-0.29	-0.41	1.08	1.36
	t-stat	-0.66	-0.19	0.04	0.87	3.41	6.60	-0.85	-0.97	-0.70	-0.96	2.02	4.01
ATM	mean	-0.30	-0.36	-0.34	-0.28	0.06	0.36	-0.03	-0.06	-0.04	-0.08	0.22	0.26
	alpha	-0.15	-0.20	-0.18	-0.11	0.26	0.41	0.08	0.06	0.09	0.07	0.38	0.31
	t-stat	-0.82	-1.06	-0.92	-0.55	1.08	3.21	0.48	0.37	0.48	0.38	1.65	2.05
ITM	mean	-0.09	-0.18	-0.17	-0.12	0.14	0.22	0.01	0.10	0.12	0.24	0.35	0.34
	alpha	-0.03	-0.13	-0.11	-0.06	0.21	0.24	0.07	0.15	0.18	0.30	0.43	0.36
	t-stat	-0.34	-1.66	-1.32	-0.71	1.90	3.41	0.81	2.24	2.39	3.55	4.16	3.98
ALL	mean	-0.30	-0.35	-0.32	-0.18	0.42	0.72	-0.20	-0.28	-0.31	-0.29	0.46	0.66
	alpha	-0.16	-0.17	-0.12	0.04	0.68	0.84	-0.09	-0.15	-0.15	-0.13	0.63	0.72
	t-stat	-0.89	-0.82	-0.54	0.15	2.36	4.82	-0.54	-0.80	-0.66	-0.52	2.08	3.38

Broader Implications of Results (I)

- Bakshi, Kapadia and Madan (2003) find that S&P500 index options are relatively more expensive than individual equity options—particularly so for short-term OTM options.
- This is a puzzle because the index should display less evidence of non-normality than individual stocks.
- Our results suggest that the difference in pricing could be driven by differences in liquidity: Index options are much more liquid than individual equity options.

Broader Implications of Results (II)

- Driessen, Maenhout and Vilkov (2009) study dispersion trades where (expensive) index options are sold and (cheaper) individual equity options are bought.
- This trade is traditionally viewed as being mainly an exposure to correlation risk: When stock correlations go up the dispersion trade looses.
- However the dispersion trade is also non-trivially exposed to liquidity risk: The individual equity options bought are much less liquid than the index options bought.

Summary

- In the cross-section, illiquid equity options earn higher average returns than do liquid equity options.
- This illiquidity premium is found to be robust across moneyness and calls/puts as well as across illiquidity measures and empirical methodologies.
- The effect on option returns of the illiquidity of the underlying stock on option returns is less strong in the data than is the effect of option illiquidity.