

Mispricing, short-sale constraints, and the cross-section of option returns

Internet Appendix

Lakshmi Shankar Ramachandran *

Jitendra Tayal †‡

*Weatherhead School of Management, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106, USA. Email: shankar@case.edu

†College of Business, Ohio University, Copeland Hall, Athens, OH 45701, USA. Email: tayal@ohio.edu

‡Corresponding author

Figure IA1: Delta-hedged option returns for long put options: RSI/IO and Utilization

The figure graphs average monthly delta-hedged option returns for long put options. At the end of each month, we create mispricing quintiles. Within each mispricing quintile, we group stocks based on one of the two measures of short-sale constraints: RSI/IO and Utilization. A long delta-hedged put position is initiated and subsequently rebalanced daily over the next month. Figure A and Figure B show variation in delta-hedged option returns based on RSI/IO and Utilization, respectively, for different levels of mispricing. Mispricing refers to a composite rank measure that is constructed monthly using the methodology in Stambaugh, Yu, and Yuan (2015). The sample period is from January 2006 to December 2017.

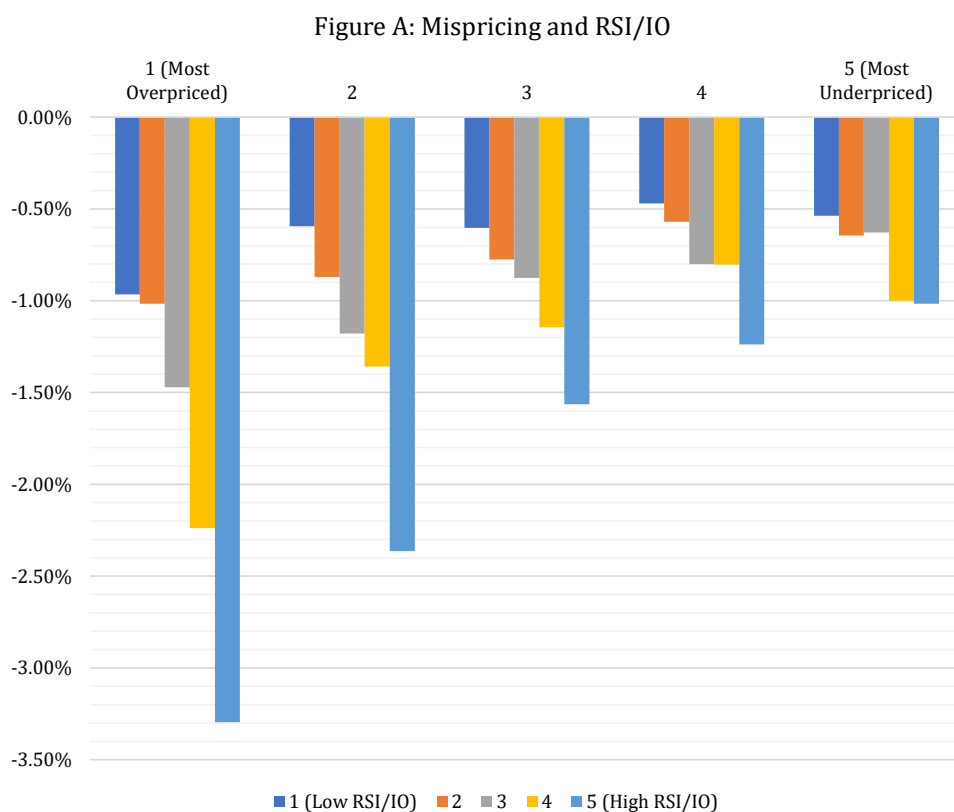


Figure B: Mispricing and Utilization

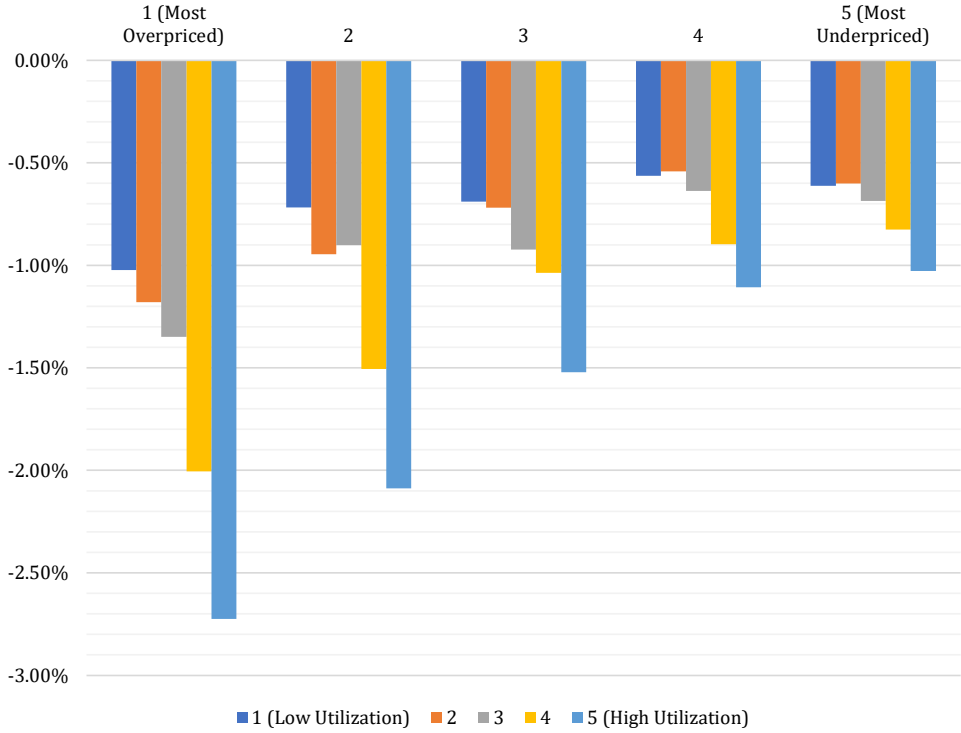


Table IA1: **Firm characteristics for mispriced groups**

This table reports average value of various characteristics for underlying stocks and selected options from January 2006 to December 2017. At the end of each month, we create mispricing quintiles. Mispricing refers to a composite rank measure that is constructed monthly using methodology in Stambaugh, Yu, and Yuan (2015). Panel A reports equity lending variables, Panel B reports equity market variables, and Panels C and D report option characteristics for selected call and put options. FEE refers to stock lending fees. OnLoan measures borrowing demand and is expressed as the percentage of shares outstanding. Supply is the shares available to lend and is expressed as the percentage of shares outstanding. Utilization measures the quantity of stock on loan from lenders divided by the total lendable quantity. RSI refers to relative short interest and is reported as a percentage of shares outstanding. IO refers to institutional ownership and is calculated as the percentage of total outstanding shares owned by institutions. Size refers to the stock's market capitalization. Beta refers to the sensitivity of the stock with respect to market. BM refers to the ratio of book value to market value. MOM refers to the intermediate term momentum and is calculated as cumulative return from month t-12 to t-2. REV refers to the short-term reversal and is calculated as the previous month's (t-1) return. MAX refers to average of five maximum returns in the previous month. IVOL refers to idiosyncratic volatility and is calculated using methodology in Ang et al. (2006). Log(ILLIQ) refers to logarithm of the Amihud (2002) illiquidity measure. Hedged returns refers to option returns of a delta-hedged long position for the following month, with daily rebalancing. OBA refers to option bid-ask spread. IV - HV refers to option expensiveness and is calculated as the difference between Implied Volatility and annualized historical total volatility at the end of every month. OI refers to open interest of options at the end of the month. #shares refers to the number of shares outstanding. TTM refers to time to maturity, i.e., the remaining time in the life of the option.

<i>Panel A: Equity Lending Variables</i>					
	1 (Most Overpriced)	2	3	4	5 (Most Underpriced)
FEE	4.03%	1.90%	1.21%	1.02%	0.84%
OnLoan	7.09%	5.96%	5.20%	4.77%	4.60%
Supply	22.04%	24.76%	26.13%	26.79%	27.79%
Utilization	36.04%	26.24%	21.16%	18.47%	16.72%
<i>Panel B: Equity Market Variables</i>					
	1 (Most Overpriced)	2	3	4	5 (Most Underpriced)
RSI	11.12%	9.00%	7.61%	7.17%	7.12%
IO	69.80%	76.54%	79.19%	80.61%	82.12%
RSI/IO	109.69%	49.20%	33.52%	29.63%	27.23%
Size (in \$mil)	3538	5318	6989	10171	12150
Beta	1.67	1.50	1.41	1.33	1.22
BM	0.58	0.54	0.48	0.43	0.36
MOM	1.41%	15.12%	20.47%	24.89%	33.10%
REV	1.50%	1.23%	1.19%	1.31%	1.06%
MAX	4.60%	3.74%	3.26%	2.97%	2.69%
IVOL	2.69%	2.14%	1.84%	1.66%	1.52%
Log(ILLIQ)	-8.85	-9.05	-9.16	-9.31	-9.44

Panel C: Put Options

	1 (Most Overpriced)	2	3	4	5 (Most Underpriced)
Hedged returns	-1.74%	-1.23%	-0.98%	-0.77%	-0.76%
OBA	16.88%	15.47%	14.97%	13.96%	12.64%
IV - HV	5.76%	3.93%	3.32%	3.04%	3.10%
OI/StockVolume	0.27%	0.23%	0.22%	0.20%	0.19%
OI/#shares	0.082%	0.064%	0.056%	0.051%	0.049%
TTM	49.60	49.59	49.56	49.53	49.50

Panel D: Call Options

	1 (Most Overpriced)	2	3	4	5 (Most Underpriced)
Hedged returns	-1.44%	-1.05%	-0.88%	-0.76%	-0.81%
OBA	19.48%	18.12%	17.40%	16.32%	14.89%
IV - HV	1.93%	2.15%	2.06%	2.07%	2.45%
OI/StockVolume	0.42%	0.36%	0.33%	0.30%	0.29%
OI/#shares	0.125%	0.098%	0.083%	0.076%	0.073%
TTM	49.61	49.59	49.59	49.56	49.52

Table IA2: **Delta-hedged option returns: Put Options**

This table reports the variation in average delta-hedged put option returns and the corresponding 4-factor alpha with mispricing. The sample period is from January 2006 to December 2017. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on three different measures of short-sale constraints (Lending fee, RSI/IO, and Utilization). We then calculate delta-hedged option returns for the following month, assuming daily rebalancing. RSI/IO refers to the ratio of relative short interest to institutional ownership. Panels A, B, and C report time-series averages of delta-hedged option return and 4-factor alpha (after controlling for Fama-French's 3-factors and Carhart's momentum factor) of equal-weighted portfolios for sorts based on Lending fee, RSI/IO, and Utilization, respectively. High – Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Mispricing and Fees</i>						
<i>Delta-hedged Option Returns</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.78% (-3.11)	-1.05% (-4.65)	-1.49% (-7.82)	-1.79% (-6.85)	-3.24% (-15.84)	-2.46% (-7.58)
2	-0.77% (-3.85)	-0.90% (-10.24)	-1.05% (-3.46)	-1.39% (-6.25)	-2.33% (-13.12)	-1.56% (-5.81)
3	-0.47% (-1.43)	-0.66% (-4.05)	-1.01% (-5.25)	-0.65% (-2.46)	-1.87% (-10.68)	-1.40% (-3.76)
4	-0.53% (-3.13)	-0.75% (-3.97)	-0.61% (-6.33)	-0.83% (-3.54)	-1.23% (-8.70)	-0.69% (-3.15)
5 (Most Underpriced)	-0.55% (-3.46)	-0.39% (-2.05)	-0.81% (-8.99)	-0.78% (-3.55)	-1.39% (-8.83)	-0.83% (-3.72)
<i>4-factor delta-hedged Alpha</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.71% (-2.84)	-1.03% (-4.48)	-1.51% (-7.68)	-1.77% (-6.84)	-3.14% (-15.29)	-2.43% (-7.48)
2	-0.70% (-3.32)	-0.91% (-9.96)	-0.97% (-3.08)	-1.43% (-6.49)	-2.27% (-12.60)	-1.57% (-5.68)
3	-0.24% (-0.71)	-0.59% (-3.74)	-1.06% (-5.12)	-0.61% (-2.37)	-1.85% (-10.26)	-1.61% (-4.20)
4	-0.52% (-2.84)	-0.83% (-4.63)	-0.61% (-5.73)	-0.88% (-3.82)	-1.17% (-8.15)	-0.65% (-2.78)
5 (Most Underpriced)	-0.49% (-2.92)	-0.40% (-2.12)	-0.82% (-8.76)	-0.81% (-3.71)	-1.35% (-8.33)	-0.86% (-3.66)

Panel B: Mispricing and RSI/IO

Delta-hedged Option Returns

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.97%	-1.02%	-1.47%	-2.24%	-3.30%	-2.33%
	(-5.79)	(-5.92)	(-9.78)	(-9.16)	(-15.60)	(-8.66)
2	-0.59%	-0.87%	-1.18%	-1.36%	-2.36%	-1.77%
	(-5.08)	(-6.21)	(-9.48)	(-9.71)	(-12.24)	(-7.84)
3	-0.60%	-0.77%	-0.88%	-1.14%	-1.56%	-0.96%
	(-5.82)	(-6.10)	(-7.14)	(-7.35)	(-9.55)	(-4.96)
4	-0.47%	-0.57%	-0.80%	-0.80%	-1.24%	-0.77%
	(-4.42)	(-5.57)	(-6.54)	(-6.90)	(-9.17)	(-4.47)
5 (Most Underpriced)	-0.54%	-0.64%	-0.63%	-1.00%	-1.02%	-0.48%
	(-5.68)	(-6.64)	(-5.64)	(-9.24)	(-7.67)	(-2.95)

4-factor delta-hedged Alpha

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.97%	-1.01%	-1.44%	-2.21%	-3.19%	-2.22%
	(-5.94)	(-5.89)	(-9.66)	(-9.05)	(-15.20)	(-8.33)
2	-0.57%	-0.85%	-1.15%	-1.33%	-2.32%	-1.75%
	(-4.81)	(-6.01)	(-9.32)	(-9.49)	(-11.99)	(-7.72)
3	-0.56%	-0.76%	-0.85%	-1.13%	-1.56%	-1.00%
	(-5.37)	(-5.92)	(-6.85)	(-7.23)	(-9.44)	(-5.14)
4	-0.42%	-0.56%	-0.78%	-0.79%	-1.18%	-0.75%
	(-4.02)	(-5.37)	(-6.35)	(-6.97)	(-8.91)	(-4.45)
5 (Most Underpriced)	-0.46%	-0.60%	-0.59%	-1.00%	-0.97%	-0.51%
	(-5.39)	(-6.26)	(-5.26)	(-9.23)	(-7.41)	(-3.23)

Panel C: Mispricing and Utilization

<i>Delta-hedged Option Returns</i>						
Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.02%	-1.18%	-1.35%	-2.00%	-2.72%	-1.70%
	(-6.50)	(-6.34)	(-6.54)	(-8.72)	(-13.61)	(-6.67)
2	-0.72%	-0.95%	-0.90%	-1.51%	-2.09%	-1.37%
	(-7.21)	(-6.29)	(-7.21)	(-9.29)	(-12.56)	(-7.07)
3	-0.69%	-0.72%	-0.92%	-1.04%	-1.52%	-0.83%
	(-6.41)	(-5.52)	(-7.27)	(-6.76)	(-9.77)	(-4.40)
4	-0.56%	-0.54%	-0.64%	-0.90%	-1.11%	-0.54%
	(-5.39)	(-5.13)	(-5.33)	(-8.56)	(-8.26)	(-3.19)
5 (Most Underpriced)	-0.61%	-0.60%	-0.69%	-0.83%	-1.03%	-0.41%
	(-6.62)	(-6.06)	(-6.44)	(-8.53)	(-7.37)	(-2.48)

<i>4-factor delta-hedged Alpha</i>						
Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.03%	-1.16%	-1.32%	-2.00%	-2.59%	-1.57%
	(-6.47)	(-6.20)	(-6.32)	(-8.63)	(-13.03)	(-6.15)
2	-0.70%	-0.96%	-0.88%	-1.50%	-2.00%	-1.30%
	(-6.89)	(-6.17)	(-7.13)	(-9.07)	(-12.06)	(-6.69)
3	-0.64%	-0.69%	-0.89%	-1.05%	-1.48%	-0.84%
	(-5.90)	(-5.17)	(-6.82)	(-6.67)	(-9.39)	(-4.39)
4	-0.52%	-0.50%	-0.62%	-0.86%	-1.04%	-0.52%
	(-4.85)	(-4.66)	(-5.09)	(-8.25)	(-7.75)	(-3.05)
5 (Most Underpriced)	-0.53%	-0.54%	-0.66%	-0.82%	-0.98%	-0.45%
	(-5.95)	(-5.57)	(-6.00)	(-8.26)	(-6.90)	(-2.70)

Table IA3: **End-user demand: Put options**

This table reports the variation in two measures of relative open interest (OI/#shares and OI/Stock Volume) of put options with mispricing. The sample period is from January 2006 to December 2017. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on three different measures of short-sale constraints (Lending fee, RSI/IO, and Utilization). RSI/IO refers to the ratio of relative short interest to institutional ownership. Panels A, B, and C report relative open interest for groups based on Lending fee, RSI/IO, and Utilization, respectively. High – Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Mispricing and Fees</i>						
<i>Relative Open Interest (OI/#shares)</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.042% (8.69)	0.037% (17.38)	0.056% (14.32)	0.079% (14.61)	0.103% (19.27)	0.062% (8.55)
2	0.028% (8.35)	0.038% (16.68)	0.048% (11.04)	0.055% (13.54)	0.101% (18.26)	0.073% (11.30)
3	0.025% (8.11)	0.044% (13.47)	0.031% (14.24)	0.052% (12.40)	0.090% (17.32)	0.066% (10.87)
4	0.032% (5.67)	0.045% (12.48)	0.029% (15.71)	0.051% (12.49)	0.087% (15.91)	0.055% (7.02)
5 (Most Underpriced)	0.031% (6.36)	0.052% (13.28)	0.028% (17.41)	0.059% (13.28)	0.086% (14.37)	0.055% (7.13)
<i>Relative Open Interest (OI/Stock Volume)</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.16% (8.68)	0.14% (20.17)	0.18% (14.25)	0.24% (14.58)	0.34% (19.10)	0.18% (7.14)
2	0.12% (8.28)	0.15% (19.78)	0.17% (12.61)	0.19% (13.89)	0.33% (18.21)	0.21% (8.99)
3	0.12% (8.04)	0.16% (15.85)	0.13% (18.22)	0.18% (12.71)	0.30% (17.70)	0.18% (7.63)
4	0.15% (5.60)	0.18% (12.64)	0.13% (19.34)	0.19% (13.29)	0.29% (15.92)	0.14% (4.36)
5 (Most Underpriced)	0.16% (5.53)	0.19% (14.75)	0.12% (22.85)	0.22% (13.27)	0.27% (16.00)	0.11% (3.45)

Panel B: Mispricing and RSI/IO

Relative Open Interest (OI/#shares)

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.03% (15.85)	0.05% (18.54)	0.06% (19.47)	0.09% (20.70)	0.12% (18.58)	0.08% (12.87)
2	0.03% (18.20)	0.03% (16.38)	0.05% (18.04)	0.07% (21.04)	0.10% (19.02)	0.08% (13.81)
3	0.02% (16.98)	0.03% (16.56)	0.04% (18.64)	0.06% (19.08)	0.09% (19.66)	0.07% (13.83)
4	0.02% (15.48)	0.03% (17.34)	0.04% (17.94)	0.05% (17.37)	0.08% (19.10)	0.06% (13.50)
5 (Most Underpriced)	0.02% (17.22)	0.03% (16.65)	0.04% (16.72)	0.06% (18.28)	0.08% (17.78)	0.06% (12.29)

Relative Open Interest (OI/Stock Volume)

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.15% (17.35)	0.18% (18.87)	0.21% (20.52)	0.28% (18.95)	0.34% (19.58)	0.19% (9.75)
2	0.14% (19.88)	0.15% (19.09)	0.18% (18.67)	0.22% (19.95)	0.30% (19.36)	0.17% (9.75)
3	0.13% (18.34)	0.15% (21.08)	0.18% (21.57)	0.20% (22.28)	0.27% (20.42)	0.14% (9.24)
4	0.13% (15.45)	0.15% (21.41)	0.16% (20.51)	0.19% (18.36)	0.26% (18.74)	0.12% (7.62)
5 (Most Underpriced)	0.14% (17.41)	0.15% (20.56)	0.16% (19.86)	0.19% (21.16)	0.23% (19.61)	0.09% (6.39)

Panel C: Mispricing and Utilization

Relative Open Interest (OI/#shares)

Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.035% (16.23)	0.044% (17.45)	0.056% (16.43)	0.076% (17.61)	0.103% (20.32)	0.067% (12.25)
2	0.028% (16.05)	0.034% (17.78)	0.047% (16.28)	0.061% (18.09)	0.095% (19.65)	0.067% (13.11)
3	0.027% (15.61)	0.034% (15.50)	0.038% (15.36)	0.052% (17.89)	0.085% (18.45)	0.058% (11.88)
4	0.025% (15.04)	0.032% (15.01)	0.035% (16.92)	0.047% (16.71)	0.077% (18.26)	0.052% (11.53)
5 (Most Underpriced)	0.024% (16.88)	0.031% (16.50)	0.039% (15.92)	0.050% (16.78)	0.074% (17.23)	0.051% (11.14)

Relative Open Interest (OI/Stock Volume)

Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.15% (17.76)	0.17% (18.72)	0.19% (17.60)	0.23% (16.50)	0.30% (19.95)	0.15% (8.81)
2	0.14% (17.92)	0.15% (19.62)	0.18% (16.54)	0.20% (18.90)	0.29% (20.36)	0.15% (9.26)
3	0.13% (17.40)	0.16% (18.86)	0.15% (17.63)	0.18% (21.21)	0.26% (20.13)	0.13% (8.38)
4	0.13% (16.26)	0.15% (17.55)	0.15% (19.05)	0.17% (19.06)	0.24% (18.21)	0.11% (7.36)
5 (Most Underpriced)	0.13% (17.23)	0.15% (18.90)	0.15% (20.30)	0.18% (19.75)	0.22% (19.11)	0.09% (6.63)

Table IA4: Dealers' response: Put options

This table reports the variation in option expensiveness (IV - HV) and option bid-ask spread (OBA) of put options with mispricing. IV - HV is calculated as the difference between Implied Volatility and annualized historical total volatility. The sample period is from January 2006 to December 2017. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on three different measures of short-sale constraints (Lending fee, RSI/IO, and Utilization). RSI/IO refers to the ratio of relative short interest to institutional ownership. Panels A, B, and C report IV - HV and OBA for groups based on Lending fee, RSI/IO, and Utilization, respectively. High - Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Mispricing and Fees</i>						
Option Expensiveness (IV - HV)						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.90%	1.93%	2.85%	6.24%	15.56%	14.65%
	(0.70)	(2.50)	(2.82)	(6.51)	(16.80)	(9.20)
2	2.38%	1.96%	2.59%	4.12%	11.10%	8.72%
	(2.81)	(3.20)	(1.76)	(4.10)	(15.17)	(7.80)
3	1.17%	2.35%	2.07%	2.36%	8.29%	7.12%
	(1.26)	(3.02)	(2.52)	(2.40)	(12.34)	(6.21)
4	3.96%	1.40%	2.61%	3.05%	6.56%	2.60%
	(4.27)	(1.89)	(4.11)	(3.24)	(9.98)	(2.28)
5 (Most Underpriced)	2.89%	2.26%	2.57%	3.36%	5.98%	3.09%
	(3.28)	(3.79)	(4.36)	(5.13)	(9.97)	(2.90)
<i>Option Bid-Ask Spread</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	13.87%	16.23%	17.82%	19.03%	18.62%	4.75%
	(19.73)	(50.82)	(41.95)	(41.23)	(44.39)	(5.81)
2	12.63%	15.39%	15.01%	16.82%	17.00%	4.37%
	(18.47)	(53.02)	(37.62)	(34.96)	(43.21)	(5.55)
3	12.96%	14.24%	15.49%	15.28%	16.86%	3.90%
	(20.94)	(41.97)	(57.47)	(36.40)	(48.92)	(5.51)
4	12.49%	13.05%	14.33%	13.96%	15.71%	3.22%
	(17.14)	(34.86)	(45.86)	(29.94)	(47.30)	(4.03)
5 (Most Underpriced)	11.26%	11.84%	12.76%	12.77%	14.56%	3.29%
	(15.74)	(34.87)	(48.44)	(36.98)	(44.86)	(4.19)

Panel B: Mispricing and RSI/IO

Option Expensiveness (IV - HV)

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.87% (1.16)	2.61% (3.41)	5.00% (6.43)	8.29% (9.44)	15.06% (16.23)	14.20% (11.92)
2	1.05% (1.69)	2.09% (3.11)	3.01% (4.35)	3.85% (5.51)	10.74% (16.22)	9.69% (10.64)
3	1.42% (2.53)	1.90% (3.31)	2.51% (4.23)	3.42% (6.14)	6.93% (11.54)	5.51% (6.70)
4	1.55% (3.22)	2.68% (5.79)	2.15% (4.17)	2.77% (4.86)	5.43% (9.73)	3.88% (5.26)
5 (Most Underpriced)	2.20% (5.11)	2.78% (6.25)	2.39% (5.26)	3.21% (6.79)	4.25% (8.04)	2.05% (3.01)

Option Bid-Ask Spread

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	15.50% (46.95)	16.54% (54.83)	16.66% (47.84)	17.53% (40.69)	18.60% (42.06)	3.10% (5.62)
2	13.49% (43.50)	15.81% (62.37)	15.52% (50.52)	15.41% (50.28)	16.98% (44.08)	3.48% (7.04)
3	12.61% (43.10)	15.31% (53.70)	15.79% (64.08)	14.94% (58.05)	15.69% (51.50)	3.08% (7.29)
4	11.68% (35.87)	14.05% (44.73)	14.97% (56.36)	14.16% (60.83)	14.69% (52.87)	3.01% (7.03)
5 (Most Underpriced)	10.57% (38.56)	12.42% (44.60)	12.73% (61.79)	13.24% (62.71)	13.44% (54.92)	2.87% (7.81)

Panel C: Mispricing and Utilization

Option Expensiveness (IV - HV)

Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.78%	3.14%	4.51%	5.96%	13.15%	12.37%
	(0.98)	(4.43)	(6.08)	(7.02)	(15.80)	(10.74)
2	1.50%	2.28%	2.71%	4.48%	9.08%	7.58%
	(2.29)	(3.32)	(4.21)	(7.18)	(12.60)	(7.79)
3	1.70%	1.97%	2.13%	3.58%	6.63%	4.93%
	(3.22)	(3.28)	(3.39)	(6.49)	(11.03)	(6.17)
4	2.08%	2.04%	2.50%	2.68%	5.42%	3.34%
	(4.27)	(4.16)	(4.83)	(5.10)	(9.47)	(4.45)
5 (Most Underpriced)	2.44%	2.48%	2.43%	3.17%	4.63%	2.19%
	(5.41)	(5.50)	(5.28)	(7.26)	(9.56)	(3.31)

Option Bid-Ask Spread

Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	15.16%	17.27%	17.24%	17.86%	17.78%	2.62%
	(48.15)	(56.26)	(52.27)	(45.23)	(39.49)	(4.77)
2	13.85%	16.09%	16.19%	15.91%	16.25%	2.39%
	(43.04)	(61.16)	(62.20)	(48.84)	(41.94)	(4.75)
3	12.98%	15.82%	16.13%	15.41%	15.39%	2.42%
	(43.35)	(61.25)	(55.83)	(64.41)	(50.96)	(5.68)
4	11.97%	14.26%	15.18%	14.52%	14.61%	2.64%
	(32.93)	(50.47)	(58.27)	(56.58)	(53.28)	(5.79)
5 (Most Underpriced)	10.99%	12.64%	13.11%	13.58%	13.27%	2.28%
	(37.36)	(40.58)	(58.09)	(57.60)	(62.95)	(6.30)

Table IA5: Delta-hedged option returns: Call Options

This table reports the variation in average delta-hedged call option returns and the corresponding 4-factor alpha with mispricing. The sample period is from January 2006 to December 2017. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on three different measures of short-sale constraints (Lending fee, RSI/IO, and Utilization). We then calculate delta-hedged option returns for the following month, assuming daily rebalancing. RSI/IO refers to the ratio of relative short interest to institutional ownership. Panels A, B, and C report time-series averages of delta-hedged option return and 4-factor alpha (after controlling for Fama-French's 3-factors and Carhart's momentum factor) of equal-weighted portfolios for sorts based on Lending fee, RSI/IO, and Utilization, respectively. High – Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Mispricing and Fees</i>						
<i>Delta-hedged Option Returns</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.11%	-1.25%	-1.25%	-2.22%	-2.39%	-1.28%
	(-3.37)	(-5.43)	(-3.22)	(-6.40)	(-6.71)	(-2.64)
2	-1.18%	-1.08%	-0.64%	-1.47%	-2.40%	-1.23%
	(-4.23)	(-4.94)	(-1.86)	(-5.38)	(-8.30)	(-3.06)
3	-0.74%	-1.12%	-0.76%	-1.15%	-1.76%	-1.03%
	(-2.39)	(-3.91)	(-3.73)	(-3.82)	(-6.76)	(-2.54)
4	-0.87%	-0.70%	-0.85%	-1.30%	-0.97%	-0.10%
	(-3.10)	(-2.30)	(-5.08)	(-3.80)	(-4.02)	(-0.28)
5 (Most Underpriced)	-1.23%	-0.85%	-0.94%	-1.00%	-0.97%	0.26%
	(-6.14)	(-2.93)	(-5.81)	(-3.32)	(-4.81)	(0.90)
<i>4-factor delta-hedged Alpha</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.92%	-0.89%	-1.01%	-1.80%	-1.98%	-1.06%
	(-3.46)	(-4.89)	(-2.68)	(-6.28)	(-6.23)	(-2.57)
2	-0.94%	-0.79%	-0.34%	-1.15%	-2.09%	-1.16%
	(-3.35)	(-4.30)	(-1.51)	(-4.54)	(-8.25)	(-3.06)
3	-0.68%	-0.90%	-0.54%	-0.86%	-1.45%	-0.77%
	(-2.24)	(-4.03)	(-3.21)	(-3.38)	(-6.47)	(-2.02)
4	-0.80%	-0.80%	-0.68%	-1.20%	-0.71%	0.09%
	(-2.71)	(-4.58)	(-4.19)	(-5.51)	(-3.26)	(0.26)
5 (Most Underpriced)	-1.15%	-0.94%	-0.66%	-0.93%	-0.77%	0.37%
	(-5.82)	(-4.93)	(-4.58)	(-3.94)	(-4.19)	(1.39)

Panel B: Mispricing and RSI/IO

Delta-hedged Option Returns

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.87%	-1.32%	-1.52%	-2.13%	-2.45%	-1.58%
	(-3.98)	(-5.07)	(-5.40)	(-6.77)	(-6.80)	(-3.76)
2	-0.87%	-0.94%	-1.17%	-1.21%	-2.04%	-1.17%
	(-4.69)	(-4.78)	(-5.53)	(-4.98)	(-7.32)	(-3.49)
3	-0.77%	-0.88%	-1.06%	-1.08%	-1.46%	-0.69%
	(-4.55)	(-5.28)	(-5.32)	(-6.17)	(-6.43)	(-2.43)
4	-0.80%	-0.85%	-0.88%	-0.96%	-1.02%	-0.22%
	(-5.54)	(-5.06)	(-5.07)	(-5.47)	(-4.91)	(-0.85)
5 (Most Underpriced)	-0.92%	-0.91%	-0.84%	-1.05%	-0.95%	-0.03%
	(-6.63)	(-5.73)	(-5.21)	(-6.67)	(-5.70)	(-0.12)

4-factor delta-hedged Alpha

Mispricing Groups	RSI/IO Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.60%	-1.04%	-1.22%	-1.87%	-2.13%	-1.53%
	(-3.57)	(-4.82)	(-5.37)	(-6.58)	(-6.54)	(-4.18)
2	-0.64%	-0.73%	-0.94%	-0.96%	-1.78%	-1.14%
	(-4.81)	(-4.64)	(-5.36)	(-4.61)	(-7.53)	(-4.19)
3	-0.58%	-0.69%	-0.85%	-0.88%	-1.23%	-0.65%
	(-4.28)	(-5.43)	(-5.21)	(-6.28)	(-6.66)	(-2.84)
4	-0.63%	-0.65%	-0.69%	-0.76%	-0.82%	-0.20%
	(-5.53)	(-4.96)	(-4.93)	(-5.51)	(-4.61)	(-0.92)
5 (Most Underpriced)	-0.76%	-0.74%	-0.64%	-0.88%	-0.81%	-0.04%
	(-7.02)	(-5.69)	(-5.20)	(-6.75)	(-5.66)	(-0.25)

Panel C: Mispricing and Utilization

<i>Delta-hedged Option Returns</i>						
Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.10%	-1.49%	-1.62%	-1.59%	-2.20%	-1.10%
	(-4.98)	(-5.82)	(-5.72)	(-5.48)	(-6.37)	(-2.68)
2	-0.93%	-1.03%	-1.08%	-1.33%	-1.94%	-1.02%
	(-4.98)	(-5.05)	(-5.40)	(-5.95)	(-7.32)	(-3.14)
3	-0.89%	-0.90%	-1.07%	-1.13%	-1.27%	-0.38%
	(-5.27)	(-5.20)	(-5.46)	(-5.74)	(-5.77)	(-1.38)
4	-0.80%	-0.89%	-0.90%	-0.96%	-0.96%	-0.17%
	(-5.50)	(-5.17)	(-5.42)	(-5.40)	(-5.00)	(-0.70)
5 (Most Underpriced)	-0.90%	-0.96%	-0.90%	-0.94%	-0.94%	-0.04%
	(-5.97)	(-6.41)	(-5.68)	(-6.93)	(-5.68)	(-0.19)

<i>4-factor delta-hedged Alpha</i>						
Mispricing Groups	Utilization Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.76%	-1.14%	-1.30%	-1.22%	-1.82%	-1.06%
	(-4.44)	(-5.51)	(-5.04)	(-4.96)	(-5.97)	(-3.03)
2	-0.63%	-0.77%	-0.82%	-1.06%	-1.64%	-1.00%
	(-4.66)	(-4.61)	(-4.82)	(-5.41)	(-7.04)	(-3.72)
3	-0.63%	-0.69%	-0.81%	-0.87%	-1.01%	-0.38%
	(-4.74)	(-4.68)	(-5.15)	(-5.35)	(-5.19)	(-1.61)
4	-0.59%	-0.64%	-0.67%	-0.75%	-0.72%	-0.13%
	(-5.22)	(-4.48)	(-5.03)	(-4.78)	(-4.40)	(-0.66)
5 (Most Underpriced)	-0.69%	-0.75%	-0.66%	-0.76%	-0.74%	-0.06%
	(-5.62)	(-6.07)	(-5.42)	(-6.65)	(-5.18)	(-0.30)

Table IA6: **Sub-sample robustness: December 2009 to December 2014**

This table reports the variation in delta-hedged option returns, relative open interest (OI/#shares), option expensiveness (IV - HV), and option bid-ask spread (OBA) with mispricing. The sample period is from December 2009 to December 2014. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on three different measures of short-sale constraints (Lending fee, RSI/IO, and Utilization). We then calculate delta-hedged option returns for the following month, assuming daily rebalancing. RSI/IO refers to the ratio of relative short interest to institutional ownership. We report time-series averages of delta-hedged option returns, relative open interest (OI/#shares), option expensiveness (IV - HV), and option bid-ask spread (OBA) in Panels A, B, C, and D, respectively. High - Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Delta-hedged Option Returns</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-0.71%	-0.87%	-1.70%	-1.48%	-3.47%	-2.76%
	(-1.88)	(-6.20)	(-6.34)	(-7.01)	(-13.96)	(-6.11)
2	-0.66%	-0.91%	-0.85%	-1.29%	-2.35%	-1.68%
	(-2.85)	(-7.59)	(-4.18)	(-5.83)	(-12.94)	(-5.70)
3	-0.78%	-0.65%	-0.98%	-0.58%	-1.84%	-1.07%
	(-3.34)	(-2.63)	(-7.91)	(-1.07)	(-9.42)	(-3.51)
4	-0.78%	-1.14%	-0.68%	-1.07%	-1.17%	-0.39%
	(-4.16)	(-5.15)	(-6.46)	(-3.19)	(-5.63)	(-1.40)
5 (Most Underpriced)	-0.76%	-0.18%	-0.82%	-0.92%	-1.36%	-0.60%
	(-3.54)	(-0.29)	(-8.10)	(-1.98)	(-8.40)	(-2.25)

<i>Panel B: Relative Open Interest (OI/#shares)</i>						
Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.03%	0.04%	0.06%	0.08%	0.11%	0.08%
	(4.07)	(15.93)	(8.79)	(13.26)	(14.50)	(7.45)
2	0.02%	0.03%	0.04%	0.06%	0.09%	0.06%
	(4.90)	(15.67)	(7.52)	(9.17)	(14.44)	(8.08)
3	0.02%	0.04%	0.03%	0.03%	0.07%	0.05%
	(6.51)	(12.42)	(14.27)	(6.32)	(13.38)	(7.63)
4	0.03%	0.03%	0.03%	0.03%	0.07%	0.05%
	(3.80)	(16.62)	(14.80)	(8.75)	(14.07)	(5.46)
5 (Most Underpriced)	0.03%	0.03%	0.03%	0.06%	0.07%	0.04%
	(3.87)	(3.45)	(19.34)	(4.13)	(11.98)	(4.75)

Panel C: Option Expensiveness (IV - HV)

Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	0.09% (0.04)	2.88% (3.38)	3.75% (2.64)	8.06% (6.59)	21.10% (16.88)	21.01% (8.18)
2	3.04% (2.38)	2.33% (2.43)	3.37% (2.89)	4.60% (2.60)	12.37% (12.09)	9.33% (5.70)
3	2.90% (1.83)	2.21% (1.28)	3.38% (4.29)	-0.45% (-0.20)	8.49% (8.38)	5.59% (2.97)
4	4.80% (4.26)	4.02% (3.06)	2.81% (3.62)	7.32% (4.66)	7.40% (8.16)	2.61% (1.80)
5 (Most Underpriced)	2.99% (2.07)	3.78% (2.44)	3.14% (4.58)	4.67% (1.98)	6.80% (7.31)	3.80% (2.21)

Panel D: Option Bid-Ask Spread

Mispricing Groups	Lending Fee Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	13.11% (9.43)	14.72% (45.94)	16.91% (26.42)	17.66% (32.29)	17.04% (49.37)	3.94% (2.75)
2	12.02% (9.07)	14.36% (37.49)	14.19% (31.02)	14.86% (17.44)	15.57% (39.18)	3.55% (2.57)
3	11.53% (11.83)	13.96% (36.60)	14.86% (43.46)	15.22% (14.85)	15.93% (38.33)	4.40% (4.15)
4	10.30% (10.62)	11.62% (19.32)	13.01% (40.39)	12.59% (12.17)	14.77% (35.74)	4.48% (4.25)
5 (Most Underpriced)	9.47% (10.12)	11.84% (16.03)	11.48% (47.11)	13.21% (9.51)	13.88% (31.75)	4.41% (4.27)

Table IA7: Delta-hedged option returns: RSI as proxy for short-sale constraints

This table reports the variation in average delta-hedged put and call option returns with mispricing. The sample period is from January 2006 to December 2017. At the end of each month, we group stocks based on the extent of mispricing. We further sort them into quintiles based on RSI (relative short interest). We then calculate delta-hedged option returns for the following month, assuming daily rebalancing. Panels A and B report delta-hedged option returns for put and call options, respectively. High – Low refers to the difference between the highest and lowest quintiles. To adjust for serial correlation, robust Newey-West (1987) t-statistics are reported in parenthesis.

<i>Panel A: Put Options</i>						
Mispricing Groups	RSI Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.24% (-7.75)	-1.59% (-9.70)	-1.79% (-9.76)	-1.91% (-9.44)	-2.31% (-10.88)	-1.07% (-4.04)
2	-0.72% (-6.40)	-0.98% (-7.28)	-1.14% (-8.76)	-1.49% (-10.16)	-1.92% (-11.75)	-1.19% (-6.02)
3	-0.57% (-5.62)	-0.86% (-7.20)	-0.92% (-6.81)	-1.16% (-8.60)	-1.40% (-9.11)	-0.83% (-4.50)
4	-0.49% (-4.95)	-0.56% (-5.68)	-0.75% (-6.32)	-0.91% (-8.53)	-1.08% (-8.79)	-0.59% (-3.72)
5 (Most Underpriced)	-0.54% (-5.93)	-0.60% (-6.69)	-0.64% (-6.47)	-0.88% (-8.36)	-0.95% (-7.24)	-0.41% (-2.58)

<i>Panel B: Call Options</i>						
Mispricing Groups	RSI Groups					High - Low
	1 (Low)	2	3	4	5 (High)	
1 (Most Overpriced)	-1.39% (-6.17)	-1.78% (-6.75)	-1.70% (-6.27)	-1.77% (-6.15)	-1.64% (-5.46)	-0.24% (-0.65)
2	-0.85% (-4.85)	-0.96% (-5.05)	-1.43% (-7.46)	-1.35% (-5.74)	-1.57% (-6.08)	-0.72% (-2.29)
3	-0.88% (-5.29)	-0.92% (-5.68)	-0.98% (-5.37)	-1.01% (-5.51)	-1.21% (-5.69)	-0.33% (-1.23)
4	-0.85% (-6.02)	-0.79% (-4.75)	-0.85% (-5.07)	-0.96% (-5.83)	-0.93% (-4.76)	-0.08% (-0.34)
5 (Most Underpriced)	-0.91% (-6.74)	-0.96% (-6.35)	-0.80% (-5.26)	-1.02% (-6.82)	-0.90% (-5.99)	0.01% (0.03)