Option Momentum

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Findings

- CBOE *VIX* index is the price of an option portfolio.
  - Apply CBOE methodology to individual firms (equity-*VIX* portfolios).
- Compute exact returns on equity-*VIX* portfolios.
  - Static option portfolio and Daily hedge (model-free).
  - Payoff of *VIX* portfolio $\approx$ Realized variance.
  - Decompose return into realized variance and option implied-variance.
- Momentum in cross-sectional equity-*VIX* returns.
  - Lasts for 5 years. No short- nor long-term reversals.
  - Quarterly seasonality.
  - Markets do not fully incorporate persistence and periodicity of stock variances.
  - Survives other option return predictors and transaction costs.

Literature

- Variance risk premium literature:
  - Carr and Wu (2009) synthetic variance swap return$= \frac{RV_{t,T}^2}{VIX_t^2} - 1$.
    - Interpolation for nontraded options + continuous time.
    - Translate continuous variance swap intuition into discrete option data.
  - Bakshi and Kapadia (2003); Bollerslev, Tauchen and Zhou (2009); Driessen, Maenhout, and Vilkov (2009).
- Momentum literature:
  - De Bondt and Thaler (1985); Heston and Sadka (2008); Jegadeesh and Titman (1993); Jones, Khorram, and Mo (2020).

VIX Portfolio

- Carr and Madan (1998):

$$\underbrace{2\int_0^\infty \frac{O(K,T,T)}{K^2}dK}_{Continuous\ Option\ Payoff} = \underbrace{-2\log(\frac{S(T)}{S(t)(1+r_f)^{T-t}})}_{log-contract\ Payoff} + \underbrace{2\left(\frac{S(T)}{S(t)(1+r_f)^{T-t}}-1\right)}_{Static\ Hedge} \tag{1}$$

- Split log-contract payoff and use daily hedge:

$$-2\sum_{u=t+1}^{T}\log(\frac{1+r(u)}{1+r_f}) + 2\sum_{u=t+1}^{T}(r(u)-r_f) \approx \sum_{u=t+1}^{T}(r(u)-r_f)^2 \tag{2}$$

- Model-free equity-*VIX* portfolio price:

$$V(t;T) = 2\sum_i \frac{O(K_i,t;T)\Delta_{K_i}}{K_i^2} \tag{3}$$

- Equity-*VIX* return: OTM options + Short static hedge + Long daily hedge

$$r_{VIX}(t,T) = \frac{V(T,T) - 2\left(\frac{S(T)}{S(t)(1+r_f)^{T-t}}-1\right) + 2\sum_{u=t+1}^{T}(r(u)-r_f)}{V(t,T)} - 1 \tag{4}$$

Sample

- Jan. 1996 to Dec. 2017.
- S&P 500 firms.
- 3rd Friday to 3rd Friday.
- Filter options by CBOE White Paper and delete options with:
  - 0 open interest;
  - 0 bid price;
  - mid-point price lower than \$0.125;
  - prices that violate arbitrage bounds.

Summary Statistics

- Compare *VIX* return with variance swap return (VSR): $\frac{\sum_{u=t+1}^{T}(r(u)-r_f)^2}{V(t,T)} - 1.$

	Mean	Std	5%	25%	50%	75%	95%
Panel A							
Number of Firms Each Month	304	111	147	203	293	411	468
Number of Strikes	6.71	4.90	4.00	4.00	6.00	8.00	14.00
Index-VIX Return(%)	-23.29	72.66	-73.10	-56.43	-37.18	-15.49	65.52
Index Variance Swap Return(%)	-24.39	74.18	-74.72	-58.32	-38.75	-13.41	60.02
Equity-VIX Return (%)	-4.19	85.52	-69.18	-42.78	-19.49	14.73	115.1
Variance Swap Return (%)	-2.64	101.93	-71.66	-48.74	-24.73	11.73	126.3
Black-Scholes Delta Elasticity	-0.05	0.09	-0.17	-0.07	-0.04	-0.02	0.00
Panel B							
EW Equity-VIX Return (%)	-3.46	32.85	-38.03	-22.88	-9.87	6.64	56.13
EW Variance Swap Return (%)	-3.23	44.19	-39.80	-26.13	-12.02	5.66	67.08
Panel C							
Correlation(Equity-VIX Return, VSR)	0.75	0.31	0.13	0.69	0.87	0.95	0.99
β_{Stock}	-2.24	2.55	-6.37	-3.36	-2.07	-0.98	1.06
β_{SP500}	-4.02	3.50	-9.75	-5.98	-3.82	-1.96	1.18
$\beta_{Mkt\ VIX}$	0.40	0.31	-0.06	0.24	0.38	0.55	0.85

- Correlation(Index-*VIX* Return, Index VSR)=0.99

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β_{Stock}	-2.24	2.55	-6.37	-3.36	-2.07	-0.98	1.06
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$\beta_{Mkt\ VIX}$	0.40	0.31	-0.06	0.24	0.38	0.55	0.85

- Correlation(EW Equity-*VIX* Return, EW VSR)=0.92

Option momentum

Jegadeesh and Titman (1993):

- J/K-month strategy:
  - Sort firms into deciles by past J months equity-VIX returns.
  - Hold winners' VIX portfolios and short losers' VIX portfolios for K months.
- Equally weighted.
- Rebalanced each month.

Option momentum

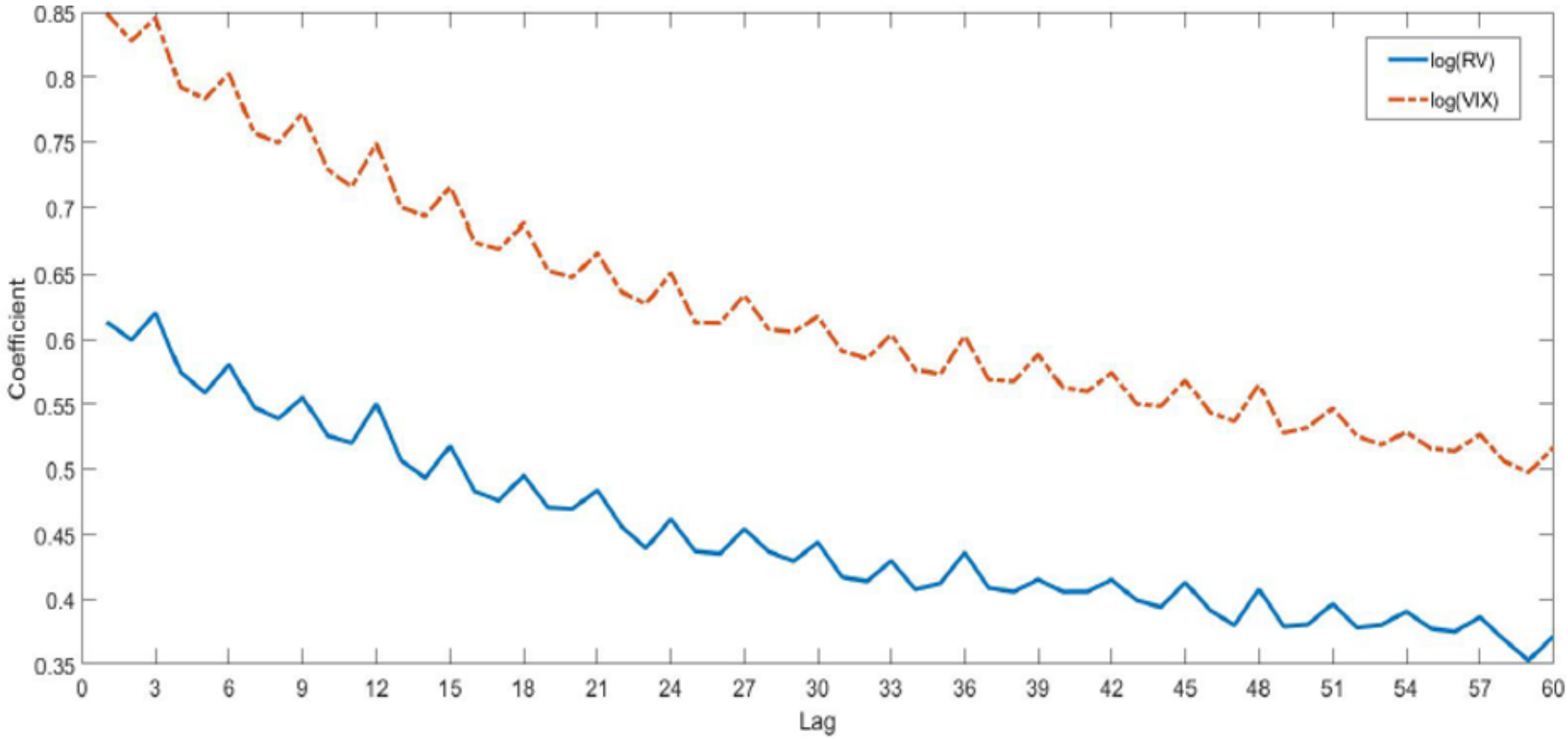
J	$K=$	3	6	9	12
3 Loser		-7.88	-6.81	-6.41	-6.42
		(-3.53)	(-3.09)	(-2.95)	(-2.94)
3 Winner		2.74	0.52	-0.93	-1.46
		(1.00)	(0.21)	(-0.39)	(-0.62)
3 Winner-Loser		10.63	7.32	5.49	4.96
		(5.90)	(5.44)	(4.67)	(4.43)
6 Loser		-8.15	-7.69	-7.03	-7.10
		(-3.48)	(-3.36)	(-3.08)	(-3.15)
6 Winner		1.93	0.37	-0.74	-1.02
		(0.69)	(0.14)	(-0.30)	(-0.41)
6 Winner-Loser		10.08	8.05	6.29	6.08
		(5.09)	(4.93)	(4.06)	(4.22)
9 Loser		-7.89	-7.61	-7.65	-7.17
		(-3.07)	(-3.16)	(-3.27)	(-3.09)
9 Winner		1.63	1.05	-0.01	-0.31
		(0.60)	(0.40)	(-0.00)	(-0.12)
9 Winner-Loser		9.52	8.67	7.64	6.86
		(4.67)	(4.82)	(4.34)	(4.19)
12 Loser		-5.60	-7.18	-6.91	-7.15
		(-2.22)	(-2.91)	(-2.83)	(-3.02)
12 Winner		1.21	0.40	-0.17	-0.91
		(0.43)	(0.15)	(-0.07)	(-0.36)
12 Winner-Loser		7.21	7.58	6.74	6.24
		(3.27)	(3.95)	(3.68)	(3.57)

Variance Decomposition

- Source of momentum profits?
- Decompose variance swap return:
  - $log(1 + VSR_{i,t}) = \underbrace{log(RV_{i,t})}_{Realized\ Variance} - \underbrace{log(VIX^2_{i,t-1})}_{Implied\ Variance}$
- Cross-sectional regressions:
  - $log(RV_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(RV_{i,t-k}) + \varepsilon_{i,t}$
  - $log(VIX^2_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(VIX^2_{i,t-k}) + \varepsilon_{i,t}$
  - $log(1 + VSR_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(1 + VSR_{i,t-k}) + \varepsilon_{i,t}$

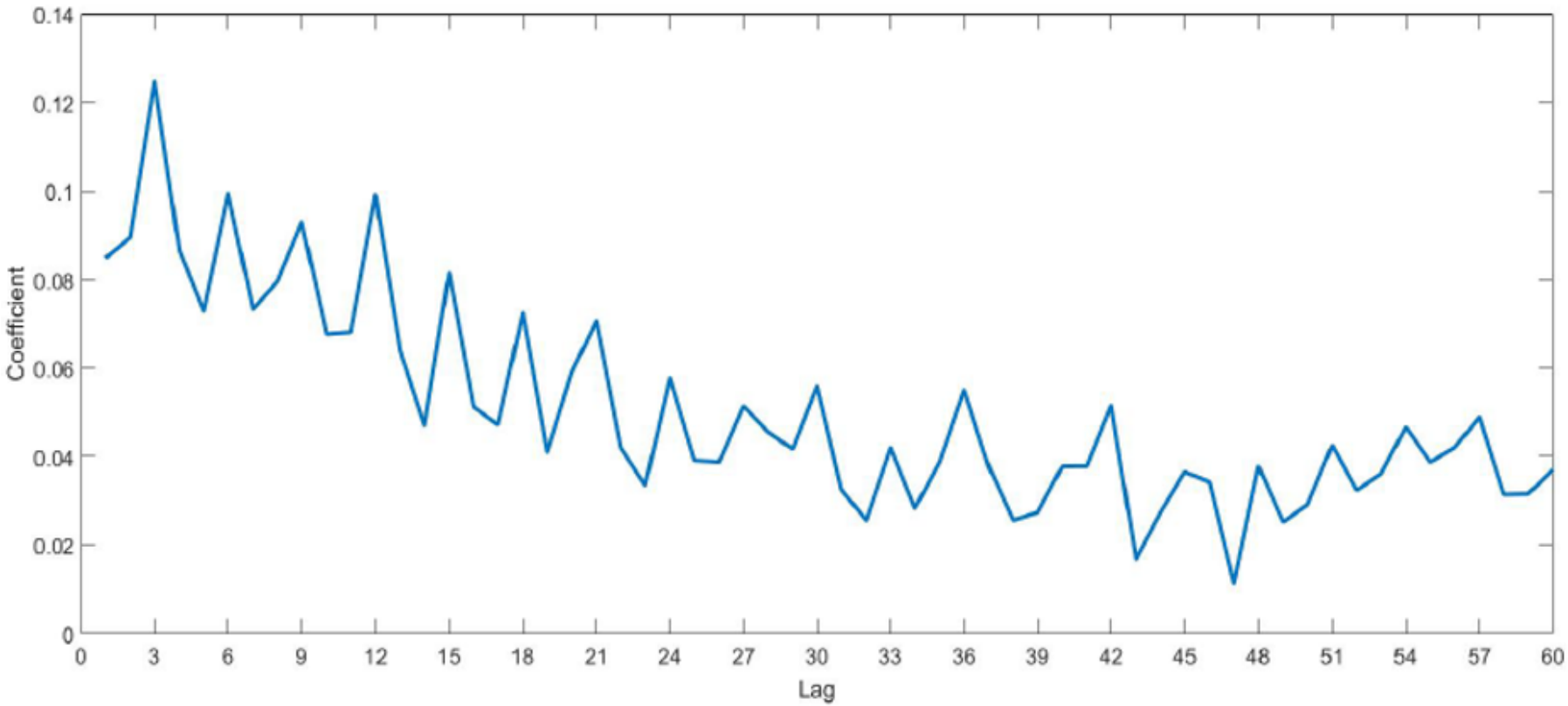
$$log(RV_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(RV_{i,t-k}) + \varepsilon_{i,t}$$

$$log(VIX^2_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(VIX^2_{i,t-k}) + \varepsilon_{i,t}$$



(a) Coefficients of $log(RV_{i,t-k})$ and $log(VIX^2_{i,t-k})$

$$log(1 + VSR_{i,t}) = \alpha_{k,t} + \gamma_{k,t} \cdot log(1 + VSR_{i,t-k}) + \varepsilon_{i,t}$$



(b) Coefficients of $log(VSR_{i,t-k})$

Seasonality

Related events:

- Earnings announcements; Dividends; Option expiration cycles.

Quarterly pattern persists after we:

- 1. Delete firms with earning announcements or dividends during the holding period.
- 2. Use firms with different option expiration cycles.

Decile Portfolio

- Sort by past $log(1 + VSR_{i,t})$; Hold equally weighted equity-VIX returns for 1 month.

- Sort by all, quarterly, and non-quarterly returns respectively:
  - All: $\frac{1}{12} \sum_{k=1}^{12} log(1 + VSR_{i,t-k})$.
  - Quarterly: $\frac{1}{4} \sum_{k=3}^{12} log(1 + VSR_{i,t-k}),\ k = 3, 6, 9, 12$.
  - Non-Quarterly: $\frac{1}{8} \sum_{k=1}^{12} log(1 + VSR_{i,t-k}),\ k \neq 3, 6, 9, 12$.

- Alpha: Fama-French 5 factors, stock momentum factor, excess index-VIX return.

Decile Sort

	Strategy	1	2	3	4	5	6	7	8	9	10	10-1	Alpha
Year 1	All	-13.47	-7.82	-4.82	-3.56	-4.86	-1.58	-1.77	0.00	1.44	2.65	16.13	16.92
												(8.42)	(8.21)
	Quarterly	-12.56	-6.97	-5.62	-2.26	-3.23	-2.47	0.72	-0.10	-0.67	2.21	14.77	15.39
												(8.75)	(8.71)
	Non-Quarterly	-11.51	-6.57	-5.56	-2.73	-2.61	-1.31	-2.17	-0.84	0.71	0.13	11.64	11.52
												(6.49)	(5.99)
Year 2	All	-9.10	-4.24	-5.13	-3.45	-2.32	-3.78	-3.97	-2.96	-1.75	-1.20	7.90	5.75
												(3.98)	(2.74)
	Quarterly	-7.26	-6.95	-2.98	-4.23	-4.62	-2.94	-1.23	-1.09	-3.85	0.54	7.80	8.27
												(4.21)	(4.15)
	Non-Quarterly	-5.92	-5.09	-6.36	-2.31	-3.52	-3.25	-1.17	-3.51	-3.50	-2.63	3.29	1.34
												(1.48)	(0.57)
Year 3	All	-7.72	-5.87	-5.67	-3.70	-6.22	-4.87	-2.65	-5.45	-3.66	-3.63	4.09	2.01
												(2.03)	(0.94)
	Quarterly	-7.05	-7.91	-6.08	-6.67	-5.44	-4.10	-2.16	-2.38	-2.56	-3.84	3.21	2.88
												(1.83)	(1.52)
	Non-Quarterly	-6.95	-4.60	-4.26	-4.58	-4.37	-5.44	-4.30	-3.79	-4.47	-5.21	1.73	0.06
												(0.97)	(0.03)
Year 4	All	-7.15	-5.63	-5.42	-4.95	-4.61	-4.76	-5.33	-4.81	-6.36	-4.21	2.94	3.11
												(1.68)	(1.65)
	Quarterly	-7.12	-5.41	-4.02	-5.71	-4.85	-5.78	-7.31	-5.47	-3.75	-1.81	5.31	4.85
												(2.96)	(2.50)
	Non-Quarterly	-6.11	-6.13	-4.35	-4.85	-4.46	-7.06	-4.64	-4.56	-5.45	-5.84	0.26	-0.67
												(0.15)	(-0.34)
Year 5	All	-6.54	-7.66	-8.57	-8.07	-5.62	-7.73	-6.14	-6.84	-5.25	-3.55	2.99	0.18
												(1.26)	(0.07)
	Quarterly	-9.89	-8.51	-6.82	-5.93	-7.63	-5.58	-7.55	-5.78	-5.99	-3.89	6.00	5.39
												(3.46)	(2.86)
	Non-Quarterly	-6.24	-6.42	-6.60	-10.19	-8.13	-6.51	-7.45	-5.39	-3.91	-4.90	1.34	-0.94
												(0.65)	(-0.343)

Decile Sort

	Strategy	1	2	3	4	5	6	7	8	9	10	10-1	Alpha
Year 1	All	-13.47	-7.82	-4.82	-3.56	-4.86	-1.58	-1.77	0.00	1.44	2.65	16.13	16.92
												(8.42)	(8.21)
	Quarterly	-12.56	-6.97	-5.62	-2.26	-3.23	-2.47	0.72	-0.10	-0.67	2.21	14.77	15.39
												(8.75)	(8.71)
	Non-Quarterly	-11.51	-6.57	-5.56	-2.73	-2.61	-1.31	-2.17	-0.84	0.71	0.13	11.64	11.52
												(6.49)	(5.99)
Year 2	All	-9.10	-4.24	-5.13	-3.45	-2.32	-3.78	-3.97	-2.96	-1.75	-1.20	7.90	5.75
												(3.98)	(2.74)
	Quarterly	-7.26	-6.95	-2.98	-4.23	-4.62	-2.94	-1.23	-1.09	-3.85	0.54	7.80	8.27
												(4.21)	(4.15)
	Non-Quarterly	-5.92	-5.09	-6.36	-2.31	-3.52	-3.25	-1.17	-3.51	-3.50	-2.63	3.29	1.34
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	Non-Quarterly	-6.11	-6.13	-4.35	-4.85	-4.46	-7.06	-4.64	-4.56	-5.45	-5.84	0.26	-0.67
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	Non-Quarterly	-11.51	-6.57	-5.56	-2.73	-2.61	-1.31	-2.17	-0.84	0.71	0.13	11.64	11.52
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Year 2	All	-9.10	-4.24	-5.13	-3.45	-2.32	-3.78	-3.97	-2.96	-1.75	-1.20	7.90	5.75
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	Quarterly	-7.26	-6.95	-2.98	-4.23	-4.62	-2.94	-1.23	-1.09	-3.85	0.54	7.80	8.27
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	Quarterly	-9.89	-8.51	-6.82	-5.93	-7.63	-5.58	-7.55	-5.78	-5.99	-3.89	6.00	5.39
												(3.46)	(2.86)
	Non-Quarterly	-6.24	-6.42	-6.60	-10.19	-8.13	-6.51	-7.45	-5.39	-3.91	-4.90	1.34	-0.94
												(0.65)	(-0.343)

Decile Sort

	Strategy	1	2	3	4	5	6	7	8	9	10	10-1	Alpha
Year 1	All	-13.47	-7.82	-4.82	-3.56	-4.86	-1.58	-1.77	0.00	1.44	2.65	16.13	16.92
												(8.42)	(8.21)
	Quarterly	-12.56	-6.97	-5.62	-2.26	-3.23	-2.47	0.72	-0.10	-0.67	2.21	14.77	15.39
												(8.75)	(8.71)
	Non-Quarterly	-11.51	-6.57	-5.56	-2.73	-2.61	-1.31	-2.17	-0.84	0.71	0.13	11.64	11.52
												(6.49)	(5.99)
Year 2	All	-9.10	-4.24	-5.13	-3.45	-2.32	-3.78	-3.97	-2.96	-1.75	-1.20	7.90	5.75
												(3.98)	(2.74)
	Quarterly	-7.26	-6.95	-2.98	-4.23	-4.62	-2.94	-1.23	-1.09	-3.85	0.54	7.80	8.27
												(4.21)	(4.15)
	Non-Quarterly	-5.92	-5.09	-6.36	-2.31	-3.52	-3.25	-1.17	-3.51	-3.50	-2.63	3.29	1.34
												(1.48)	(0.57)
Year 3	All	-7.72	-5.87	-5.67	-3.70	-6.22	-4.87	-2.65	-5.45	-3.66	-3.63	4.09	2.01
												(2.03)	(0.94)
	Quarterly	-7.05	-7.91	-6.08	-6.67	-5.44	-4.10	-2.16	-2.38	-2.56	-3.84	3.21	2.88
												(1.83)	(1.52)
	Non-Quarterly	-6.95	-4.60	-4.26	-4.58	-4.37	-5.44	-4.30	-3.79	-4.47	-5.21	1.73	0.06
												(0.97)	(0.03)
Year 4	All	-7.15	-5.63	-5.42	-4.95	-4.61	-4.76	-5.33	-4.81	-6.36	-4.21	2.94	3.11
												(1.68)	(1.65)
	Quarterly	-7.12	-5.41	-4.02	-5.71	-4.85	-5.78	-7.31	-5.47	-3.75	-1.81	5.31	4.85
												(2.96)	(2.50)
	Non-Quarterly	-6.11	-6.13	-4.35	-4.85	-4.46	-7.06	-4.64	-4.56	-5.45	-5.84	0.26	-0.67
												(0.15)	(-0.34)
Year 5	All	-6.54	-7.66	-8.57	-8.07	-5.62	-7.73	-6.14	-6.84	-5.25	-3.55	2.99	0.18
												(1.26)	(0.07)
	Quarterly	-9.89	-8.51	-6.82	-5.93	-7.63	-5.58	-7.55	-5.78	-5.99	-3.89	6.00	5.39
												(3.46)	(2.86)
	Non-Quarterly	-6.24	-6.42	-6.60	-10.19	-8.13	-6.51	-7.45	-5.39	-3.91	-4.90	1.34	-0.94
												(0.65)	(-0.343)

Risk-adjusted Returns

Momentum strategy sorted by past 12 months.

	Loser	Winner	W-L
Alpha	-0.051***	0.119***	0.169***
	(-3.63)	(5.99)	(8.21)
Index VIX Ret-Rf	0.345***	0.395***	0.050
	(15.85)	(12.81)	(1.56)
MKT-Rf	-0.397	-0.002	0.395
	(-1.05)	(-0.00)	(0.71)
SMB	-0.962*	-1.237	-0.275
	(-1.82)	(-1.65)	(-0.35)
HML	-0.653	0.141	0.794
	(-1.34)	(0.20)	(1.10)
RMW	-0.096	0.543	0.639
	(-0.15)	(0.61)	(0.69)
CMA	-0.049	-1.231	-1.182
	(-0.06)	(-1.04)	(-0.95)
Stock MOM	0.022	-0.047	-0.069
	(0.11)	(-0.17)	(-0.24)
Adj.R^2	0.637	0.517	-0.004

Option Value vs. Momentum

- **Value**: $log(\frac{RV_{i,t-12,t}}{VIX^2_{i,t}})$.
- **Momentum**: $\frac{1}{12}\sum_{k=1}^{12} log(1 + VSR_{i,t-k})$.

	Momentum						
Value	1 (Low)	2	3	4	5 (High)	5-1	Alpha
1 (Low)	-19.98	-13.66	-12.55	-9.63	-5.84	14.13	15.46
						(5.21)	(5.48)
2	-9.50	-8.14	-4.14	-5.83	-2.85	6.64	10.15
						(2.95)	(4.35)
3	-4.41	-4.40	-5.58	-2.90	1.07	5.48	2.99
						(2.18)	(1.13)
4	-3.23	0.19	0.89	-0.19	2.70	5.93	7.56
						(2.04)	(2.42)
5 (High)	-1.07	5.23	5.39	3.03	7.42	8.49	9.56
						(3.00)	(3.11)
All	-10.62	-4.20	-3.22	-0.87	2.04	12.67	12.69
						(8.48)	(7.93)

Control for other option return predictors

$$r_{i,t+1} = \alpha_t + \gamma_t \cdot \textit{Option Momentum}_{i,t} + \theta_t \textit{Controls}_{i,t} + \epsilon_{i,t+1}$$

- Control for option return predictors:
  - Goyal and Sarreto (2009): Volatility deviation (HV-IV).
  - Cao and Han (2013): Idiosyncratic volatility (IVOL).
  - Vasquez (2017): Slope of volatility term structures (Slope_VTS).
  - Cao et al. (2019): Volatility of volatility (VOV).
  - Bakshi et al. (2003): Risk-neutral skewness (RN_Skew).
  - Amihud illiquidity, Option demand pressure.
  - Cao et al. (2017): Size, Book-to-market, $\textit{Stock\_Ret}_{i,t-1,t}$, $\textit{Stock\_Ret}_{i,t-12,t-1}$, Analyst dispersion, Cash holdings, Profitability, New stock issues.
- Additional testing assets:
  - Delta-hedged ATM call/put returns (Bakshi and Kapadia (2003)).

Cross-Sectional Regressions

	Equity-VIX Return		Delta-hedged Call		Delta-hedged Put	
	(1)	(2)	(3)	(4)	(5)	(6)
Option MOM	0.152***	0.115***	0.007***	0.005***	0.007***	0.005***
	(8.30)	(6.05)	(7.25)	(6.71)	(8.27)	(6.13)
HV-IV		0.113***		0.009***		0.009***
		(2.72)		(4.57)		(4.79)
IVOL		-2.629***		-0.171***		-0.120***
		(-2.82)		(-4.48)		(-3.18)
Slope_VTS		0.640***		0.046***		0.048***
		(4.40)		(6.76)		(7.44)
VOV		-0.664***		-0.012		-0.028***
		(-3.00)		(-1.23)		(-3.08)
RN_Skew		0.017		-0.001***		0.002***
		(1.24)		(-2.72)		(3.61)
Option Demand		-0.005***		-0.000***		-0.000**
		(-3.67)		(-3.11)		(-2.05)
Amihud		88.835		1.960		3.350
		(1.34)		(0.85)		(1.38)
Size		0.003		-0.000		-0.000
		(0.37)		(-0.25)		(-0.21)
Book-to-Market		0.001		0.000		-0.000
		(0.19)		(0.72)		(-0.80)
$RET_{t-1,t}$		-0.171**		-0.009***		-0.012***
		(-2.25)		(-2.60)		(-3.76)
$RET_{t-12,t-1}$		0.019		-0.002**		-0.001
		(0.79)		(-2.15)		(-1.41)
Analyst Dispersion		-0.052		0.002		0.002
		(-0.91)		(0.70)		(0.81)
Cash Holding		0.029		-0.000		0.002*
		(1.04)		(-0.26)		(1.91)
Profitability		-0.016		0.001		0.001
		(-0.81)		(1.63)		(0.62)
Issue		0.082		0.005**		0.005**
		(1.60)		(2.15)		(2.55)
Intercept	-0.003	0.012	0.001	0.004	-0.003***	0.000
	(-0.14)	(0.08)	(0.75)	(0.85)	(-3.62)	(0.08)
R^2	0.016	0.160	0.017	0.194	0.019	0.190

Cross-Sectional Regressions

	Equity-VIX Return		Delta-hedged Call		Delta-hedged Put	
	(1)	(2)	(3)	(4)	(5)	(6)
Option MOM	0.152***	0.115***	0.007***	0.005***	0.007***	0.005***
	(8.30)	(6.05)	(7.25)	(6.71)	(8.27)	(6.13)
HV-IV		0.113***		0.009***		0.009***
		(2.72)		(4.57)		(4.79)
IVOL		-2.629***		-0.171***		-0.120***
		(-2.82)		(-4.48)		(-3.18)
Slope_VTS		0.640***		0.046***		0.048***
		(4.40)		(6.76)		(7.44)
VOV		-0.664***		-0.012		-0.028***
		(-3.00)		(-1.23)		(-3.08)
RN_Skew		0.017		-0.001***		0.002***
		(1.24)		(-2.72)		(3.61)
Option Demand		-0.005***		-0.000***		-0.000**
		(-3.67)		(-3.11)		(-2.05)
Amihud		88.835		1.960		3.350
		(1.34)		(0.85)		(1.38)
Size		0.003		-0.000		-0.000
		(0.37)		(-0.25)		(-0.21)
Book-to-Market		0.001		0.000		-0.000
		(0.19)		(0.72)		(-0.80)
$RET_{t-1,t}$		-0.171**		-0.009***		-0.012***
		(-2.25)		(-2.60)		(-3.76)
$RET_{t-12,t-1}$		0.019		-0.002**		-0.001
		(0.79)		(-2.15)		(-1.41)
Analyst Dispersion		-0.052		0.002		0.002
		(-0.91)		(0.70)		(0.81)
Cash Holding		0.029		-0.000		0.002*
		(1.04)		(-0.26)		(1.91)
Profitability		-0.016		0.001		0.001
		(-0.81)		(1.63)		(0.62)
Issue		0.082		0.005**		0.005**
		(1.60)		(2.15)		(2.55)
Intercept	-0.003	0.012	0.001	0.004	-0.003***	0.000
	(-0.14)	(0.08)	(0.75)	(0.85)	(-3.62)	(0.08)
R^2	0.016	0.160	0.017	0.194	0.019	0.190

Option Bid-Ask Spread

- Effective spread as a % of quoted spread.
- Muravyev and Pearson (2020): Effective spreads of traders who time executions are less than 40%.

Panel A: Option momentum returns

	Percentage of Quoted Bid-Ask Spread			
	0%	50%	75%	100%
All	16.13	6.74	1.86	-3.22
	(8.42)	(3.62)	(1.00)	(-1.69)
Quarterly	14.77	5.85	1.24	-3.53
	(8.75)	(3.55)	(0.75)	(-2.08)
Non-Quarterly	11.64	2.52	-2.31	-7.46
	(6.49)	(1.44)	(-1.30)	(-4.08)
Panel B: Percentage bid-ask spread lower than median.				
All	17.05	13.25	11.17	9.08
	(5.66)	(4.48)	(3.78)	(3.08)
Quarterly	13.91	11.53	9.35	7.17
	(5.52)	(4.08)	(3.31)	(2.53)
Non-Quarterly	11.95	8.13	6.03	3.93
	(4.90)	(3.43)	(2.54)	(1.65)

Option Bid-Ask Spread

- Effective spread as a % of quoted spread.
- Muravyev and Pearson (2020): Effective spreads of traders who time executions are less than 40%.

Panel A: Option momentum returns

	Percentage of Quoted Bid-Ask Spread			
	0%	50%	75%	100%
All	16.13	6.74	1.86	-3.22
	(8.42)	(3.62)	(1.00)	(-1.69)
Quarterly	14.77	5.85	1.24	-3.53
	(8.75)	(3.55)	(0.75)	(-2.08)
Non-Quarterly	11.64	2.52	-2.31	-7.46
	(6.49)	(1.44)	(-1.30)	(-4.08)
Panel B: Percentage bid-ask spread lower than median.				
All	17.05	13.25	11.17	9.08
	(5.66)	(4.48)	(3.78)	(3.08)
Quarterly	13.91	11.53	9.35	7.17
	(5.52)	(4.08)	(3.31)	(2.53)
Non-Quarterly	11.95	8.13	6.03	3.93
	(4.90)	(3.43)	(2.54)	(1.65)

Conclusion

- Compute exact returns on equity-*VIX* portfolios.
  - Tradable.
  - Measures variance risk premium.

- Momentum and seasonality exists in option market.
  - Distinct from stock momentum.
  - Markets do not fully incorporate the persistence and periodicity of stock variances.
  - Can't be explained by other predictors and transaction costs.