Time Series and Cross Sectional Momentum in the Cryptocurrency Market :A Comprehensive Analysis under Realistic Assumptions

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Summary statistics of the cryptocurreny market and equity market

	Mean	Std	Sharpe	Cum	MDD
MKT	61.48	73.55	0.84	2481.37	89.20
MKT-EW	75.60	88.30	0.86	2970.30	97.06
Bitcoin	61.75	71.90	0.86	2958.32	83.40
Ethereum	146.05	113.22	1.29	59509.88	94.00
NASDAQ 100	25.43	26.43	0.96	325.81	35.60

- Crypto currency market is more profitable
(in terms of mean return and cumulative return)

- Higher return is not a free lunch, you must endure higher volatility and drawdowns

- It is hard to model fundamental value of cryptocurrency, so many previous researches focus on ‘price’ based models. For instance, ‘Momentum’

Momentum?

Cross sectional
- Jegadeesh et al. (JF 1993), Asness et al. (JF 2013), Liu et al. (JF 2022)

Time series
- Moskowitz et al. (JFE 2012), Lim et al. (JBF 2018), Liu & Tsyvinski (RFS 2020)

A	B	C	D	E	F
+ 9	- 10	+ 4	+ 1	- 2	+ 5

Cross sectional
- Long (A, F, C)
- Short (B, D, E)

Time series
- Long (A, C, D, F)
- Short (B, E)

Motivation & Contribution

Different reports about cryptocurrency momentum

- Exist: Tzouvanas et al. (2020), Liu & Tsyvinski (2020), Lit et al. (2022)
- Not exist: Grobys and Sapkota (2019), Jia et al. (2022)

→ Construct portfolios with different look-back and holding pairs and make comprehensive conclusion

Recent shocks need to be considered as a nature of cryptocurrency

- Terra-Luna crash, bankruptcy of FTX

→ Utilize recent data ~ 2023.08.23

Regression based approach underestimates risk

- Cryptocurrency returns have lots of '**jump**' and '**crash**'

→ While taking a short position, probability of margin call always exists (it happens more often than not!)

→ For practical usage, maximum drawdown should be considered

Data description

Source: CoinMarketCap, Binance

Number of coins and Market Cap by Different Filtering Methods

	Number				Market Cap (100 mil)			
Year	None	M	V	M&V	None	M	V	M&V
2014	287	27	3	3	75.21	74.49	64.27	64.27
2015	483	31	3	2	45.18	44.75	41.35	41.35
2016	499	55	5	5	107.38	106.49	101.40	101.28
2017	579	173	54	51	1259.97	1238.89	1227.70	1219.16
2018	711	459	192	178	2967.85	2946.98	2906.97	2898.86
2019	1080	568	213	187	2079.26	2073.28	2043.33	2039.56
2020	1559	727	317	273	3173.84	3151.23	3100.53	3087.22
2021	3102	1296	832	637	18574.06	18379.38	18278.61	18242.30
2022	6571	1422	883	616	12055.43	12025.12	11860.30	11847.07
2023	8967	1362	694	526	10310.87	10283.71	10125.91	10114.56

- We select cryptocurrencies that have 30 days moving average market capitalization and trading volume over than 1 million

- Cryptocurrencies have lots of jumps, applying moving average make the number of coins in our portfolio stable and smooth

Time-series momentum regression analysis

	Holding period (k)										
Look-back (j)	1	3	5	7	14	21	28	35	42	49	56
1	-0.032	0.026	0.020	0.036	0.045	0.041	0.054	0.052	0.041	0.048	0.047
	(-1.79)	(1.43)	(1.06)	(1.93)	(2.29)	(1.93)	(2.63)	(2.46)	(1.93)	(2.23)	(2.25)
3	0.026	0.055	0.067	0.063	0.077	0.068	0.083	0.084	0.066	0.070	0.065
	(1.43)	(2.37)	(2.60)	(2.38)	(2.54)	(2.13)	(2.70)	(2.67)	(1.97)	(2.13)	(2.00)
5	0.023	0.068	0.070	0.069	0.092	0.075	0.096	0.090	0.075	0.079	0.070
	(1.26)	(2.67)	(2.51)	(2.31)	(2.54)	(1.95)	(2.57)	(2.36)	(1.84)	(1.96)	(1.72)
7	0.049	0.075	0.078	0.074	0.108	0.091	0.110	0.099	0.086	0.087	0.078
	(2.73)	(2.81)	(2.57)	(2.31)	(2.67)	(2.11)	(2.61)	(2.23)	(1.82)	(1.84)	(1.66)
14	0.061	0.099	0.107	0.117	0.127	0.132	0.134	0.119	0.103	0.100	0.091
	(3.21)	(3.33)	(3.01)	(3.02)	(2.76)	(2.71)	(2.57)	(2.08)	(1.68)	(1.6)	(1.45)
21	0.065	0.089	0.092	0.102	0.126	0.123	0.124	0.109	0.095	0.090	0.090
	(3.45)	(3.04)	(2.63)	(2.71)	(2.69)	(2.40)	(2.15)	(1.67)	(1.36)	(1.27)	(1.27)
28	0.075	0.101	0.105	0.120	0.134	0.132	0.127	0.111	0.099	0.100	0.108
	(4.08)	(3.57)	(3.20)	(3.28)	(2.69)	(2.30)	(2.00)	(1.54)	(1.32)	(1.31)	(1.42)
35	0.074	0.101	0.102	0.112	0.125	0.119	0.117	0.103	0.098	0.106	0.116
	(3.83)	(3.33)	(2.82)	(2.71)	(2.23)	(1.88)	(1.65)	(1.38)	(1.25)	(1.35)	(1.47)
42	0.069	0.091	0.084	0.091	0.103	0.097	0.095	0.097	0.100	0.107	0.116
	(3.38)	(2.80)	(2.13)	(2.03)	(1.73)	(1.43)	(1.26)	(1.23)	(1.27)	(1.35)	(1.45)
49	0.065	0.083	0.077	0.086	0.092	0.082	0.092	0.106	0.108	0.111	0.124
	(2.95)	(2.43)	(1.87)	(1.83)	(1.49)	(1.14)	(1.19)	(1.32)	(1.34)	(1.39)	(1.53)
56	0.067	0.084	0.073	0.079	0.085	0.091	0.111	0.125	0.130	0.140	0.150
	(3.06)	(2.37)	(1.68)	(1.63)	(1.36)	(1.28)	(1.43)	(1.55)	(1.60)	(1.72)	(1.83)

- Statistically significant and positive coefficients represent **momentum**
- Strong momentum is found with look-back (7~28) and holding (1~14) pairs

Standard errors are Newey-West (1987) adjusted

Time-series momentum regression analysis

	Holding period (k)										
Look-back (j)	1	3	5	7	14	21	28	35	42	49	56
1	-0.032	0.026	0.020	0.036	0.045	0.041	0.054	0.052	0.041	0.048	0.047
	(-1.79)	(1.43)	(1.06)	(1.93)	(2.29)	(1.93)	(2.63)	(2.46)	(1.93)	(2.23)	(2.25)
3	0.026	0.055	0.067	0.063	0.077	0.068	0.083	0.084	0.066	0.070	0.065
	(1.43)	(2.37)	(2.60)	(2.38)	(2.54)	(2.13)	(2.70)	(2.67)	(1.97)	(2.13)	(2.00)
5	0.023	0.068	0.070	0.069	0.092	0.075	0.096	0.090	0.075	0.079	0.070
	(1.26)	(2.67)	(2.51)	(2.31)	(2.54)	(1.95)	(2.57)	(2.36)	(1.84)	(1.96)	(1.72)
7	0.049	0.075	0.078	0.074	0.108	0.091	0.110	0.099	0.086	0.087	0.078
	(2.73)	(2.81)	(2.57)	(2.31)	(2.67)	(2.11)	(2.61)	(2.23)	(1.82)	(1.84)	(1.66)
14	0.061	0.099	0.107	0.117	0.127	0.132	0.134	0.119	0.103	0.100	0.091
	(3.21)	(3.33)	(3.01)	(3.02)	(2.76)	(2.71)	(2.57)	(2.08)	(1.68)	(1.6)	(1.45)
21	0.065	0.089	0.092	0.102	0.126	0.123	0.124	0.109	0.095	0.090	0.090
	(3.45)	(3.04)	(2.63)	(2.71)	(2.69)	(2.40)	(2.15)	(1.67)	(1.36)	(1.27)	(1.27)
28	0.075	0.101	0.105	0.120	0.134	0.132	0.127	0.111	0.099	0.100	0.108
	(4.08)	(3.57)	(3.20)	(3.28)	(2.69)	(2.30)	(2.00)	(1.54)	(1.32)	(1.31)	(1.42)
35	0.074	0.101	0.102	0.112	0.125	0.119	0.117	0.103	0.098	0.106	0.116
	(3.83)	(3.33)	(2.82)	(2.71)	(2.23)	(1.88)	(1.65)	(1.38)	(1.25)	(1.35)	(1.47)
42	0.069	0.091	0.084	0.091	0.103	0.097	0.095	0.097	0.100	0.107	0.116
	(3.38)	(2.80)	(2.13)	(2.03)	(1.73)	(1.43)	(1.26)	(1.23)	(1.27)	(1.35)	(1.45)
49	0.065	0.083	0.077	0.086	0.092	0.082	0.092	0.106	0.108	0.111	0.124
	(2.95)	(2.43)	(1.87)	(1.83)	(1.49)	(1.14)	(1.19)	(1.32)	(1.34)	(1.39)	(1.53)
56	0.067	0.084	0.073	0.079	0.085	0.091	0.111	0.125	0.130	0.140	0.150
	(3.06)	(2.37)	(1.68)	(1.63)	(1.36)	(1.28)	(1.43)	(1.55)	(1.60)	(1.72)	(1.83)

- Statistically significant and positive coefficients represent **momentum**
- Strong momentum is found with look-back (7~28) and holding (1~14) pairs

Standard errors are Newey-West (1987) adjusted

Cross-sectional momentum regression analysis

	Holding period (k)										
Look-back (j)	1	3	5	7	14	21	28	35	42	49	56
1	-0.062	-0.040	-0.022	-0.029	-0.030	-0.034	-0.019	-0.002	-0.038	-0.028	-0.024
	(-52.16)	(-18.85)	(-8.16)	(-8.97)	(-6.44)	(-5.88)	(-2.88)	(-0.32)	(-4.68)	(-3.24)	(-2.38)
3	-0.062	-0.049	-0.033	-0.027	-0.010	-0.020	-0.013	-0.007	-0.009	-0.008	-0.014
	(-29.05)	(-22.84)	(-11.04)	(-7.22)	(-2.08)	(-3.31)	(-1.67)	(-0.91)	(-1.02)	(-0.85)	(-1.43)
5	-0.051	-0.030	-0.026	-0.027	-0.013	0.003	-0.015	-0.005	-0.020	0.013	-0.019
	(-18.56)	(-10.79)	(-9.35)	(-6.81)	(-2.65)	(0.39)	(-2.10)	(-0.61)	(-2.05)	(1.35)	(-1.72)
7	-0.053	-0.028	-0.023	-0.026	-0.016	-0.015	-0.013	0.005	-0.010	-0.008	-0.025
	(-16.17)	(-8.34)	(-6.91)	(-7.73)	(-3.44)	(-2.57)	(-1.80)	(0.65)	(-1.08)	(-0.79)	(-2.34)
14	-0.040	-0.017	-0.013	-0.015	-0.018	-0.013	-0.003	-0.012	-0.012	-0.027	-0.034
	(-8.49)	(-3.57)	(-2.67)	(-3.16)	(-3.76)	(-1.84)	(-0.43)	(-1.32)	(-1.29)	(-2.52)	(-3.17)
21	-0.028	-0.009	-0.019	-0.019	-0.012	-0.017	-0.038	-0.030	-0.039	-0.023	-0.013
	(-4.97)	(-1.52)	(-3.21)	(-3.27)	(-1.98)	(-2.81)	(-4.39)	(-3.32)	(-4.19)	(-2.09)	(-1.12)
28	0.00	-0.018	-0.018	-0.022	-0.039	-0.024	-0.026	-0.045	-0.053	-0.042	-0.046
	(0.07)	(-2.74)	(-2.54)	(-3.23)	(-5.59)	(-3.34)	(-3.59)	(-4.22)	(-5.05)	(-3.96)	(-4.20)
35	0.014	-0.003	-0.017	-0.015	-0.036	-0.022	-0.027	-0.027	-0.034	-0.027	-0.015
	(1.79)	(-0.42)	(-2.22)	(-1.93)	(-4.53)	(-2.81)	(-3.42)	(-3.29)	(-2.97)	(-2.24)	(-1.23)
42	-0.022	-0.024	-0.037	-0.043	-0.056	-0.044	-0.065	-0.044	-0.050	-0.034	-0.047
	(-2.69)	(-3.01)	(-4.32)	(-5.17)	(-6.63)	(-4.9)	(-7.16)	(-4.78)	(-5.33)	(-2.47)	(-3.14)
49	-0.048	-0.064	-0.072	-0.057	-0.055	-0.030	-0.020	-0.039	-0.028	-0.036	-0.063
	(-5.24)	(-6.95)	(-7.71)	(-5.95)	(-5.55)	(-2.91)	(-1.97)	(-3.68)	(-2.72)	(-3.31)	(-4.51)
56	-0.003	-0.052	-0.053	-0.055	-0.091	-0.06	-0.060	-0.064	-0.066	-0.052	-0.046
	(-0.32)	(-5.50)	(-5.46)	(-5.56)	(-8.84)	(-5.56)	(-5.58)	(-5.78)	(-6.05)	(-4.72)	(-4.04)

- Statistically significant and negative coefficients represent **reversal**

Standard errors are Newey-West (1987) adjusted

Cross-sectional momentum regression analysis – Top 5%

	Holding period (k)										
Look-back (j)	1	3	5	7	14	21	28	35	42	49	56
1	0.017	0.039	0.038	0.052	0.060	0.062	0.060	0.057	0.051	0.049	0.048
	(2.95)	(6.57)	(6.12)	(8.35)	(8.71)	(8.36)	(7.48)	(6.79)	(5.74)	(5.29)	(4.90)
3	0.019	0.028	0.041	0.047	0.065	0.066	0.066	0.053	0.048	0.046	0.040
	(3.43)	(3.90)	(5.10)	(5.52)	(6.83)	(6.54)	(6.37)	(4.85)	(4.22)	(3.96)	(3.39)
5	0.009	0.026	0.032	0.035	0.058	0.060	0.061	0.041	0.036	0.036	0.029
	(1.61)	(3.40)	(3.73)	(3.67)	(5.29)	(5.15)	(4.97)	(3.23)	(2.72)	(2.70)	(2.10)
7	0.017	0.025	0.030	0.034	0.060	0.059	0.054	0.034	0.028	0.026	0.020
	(2.98)	(3.07)	(3.18)	(3.31)	(4.97)	(4.59)	(4.02)	(2.39)	(1.96)	(1.82)	(1.34)
14	0.016	0.033	0.041	0.047	0.067	0.058	0.039	0.019	0.013	0.004	-0.001
	(2.61)	(3.91)	(4.00)	(4.10)	(4.86)	(3.76)	(2.31)	(1.09)	(0.75)	(0.24)	(-0.04)
21	0.017	0.032	0.041	0.044	0.054	0.031	0.012	-0.005	-0.015	-0.019	-0.019
	(2.76)	(3.66)	(3.87)	(3.65)	(3.56)	(1.88)	(0.63)	(-0.24)	(-0.74)	(-0.93)	(-0.94)
28	0.012	0.028	0.036	0.033	0.025	0.003	-0.015	-0.032	-0.039	-0.040	-0.037
	(1.90)	(3.18)	(3.36)	(2.69)	(1.58)	(0.17)	(-0.78)	(-1.56)	(-1.86)	(-1.85)	(-1.67)
35	0.005	0.012	0.014	0.010	0.003	-0.017	-0.036	-0.051	-0.053	-0.052	-0.050
	(0.80)	(1.22)	(1.22)	(0.78)	(0.16)	(-0.92)	(-1.79)	(-2.40)	(-2.41)	(-2.28)	(-2.15)
42	0.002	0.006	0.008	0.004	-0.008	-0.031	-0.049	-0.059	-0.058	-0.058	-0.056
	(0.27)	(0.63)	(0.66)	(0.28)	(-0.43)	(-1.56)	(-2.29)	(-2.62)	(-2.55)	(-2.45)	(-2.26)
49	-0.001	0.001	0.003	-0.002	-0.019	-0.043	-0.057	-0.064	-0.064	-0.063	-0.060
	(-0.16)	(0.15)	(0.26)	(-0.17)	(-1.04)	(-2.08)	(-2.58)	(-2.74)	(-2.66)	(-2.56)	(-2.32)
56	-0.005	-0.007	-0.006	-0.012	-0.028	-0.048	-0.063	-0.069	-0.068	-0.066	-0.064
	(-0.65)	(-0.66)	(-0.50)	(-0.86)	(-1.51)	(-2.30)	(-2.74)	(-2.88)	(-2.74)	(-2.56)	(-2.45)

- Zaremba et al. (2021), Liu et al. (2022) reports momentum works better in large coins

Standard errors are Newey-West (1987) adjusted

Portfolio formation method

Time-series

1) Take grid of pairs (j,k) where significantly positive coefficients are concentrated.
2) If no position, evaluate whether look-back period return is in top 1/3 of historical returns.
3) If so, take long position on the market.
4) Else if look-back period return is in bottom 1/3, take short position.
5) Else clear the whole existing position

Cross-sectional

1) Take grid of pairs (j,k) where significantly significant coefficients are concentrated.
2) At every re-balancing day, take long position on cryptocurrencies

with top 1/3 look-back return and short bottom 1/3.

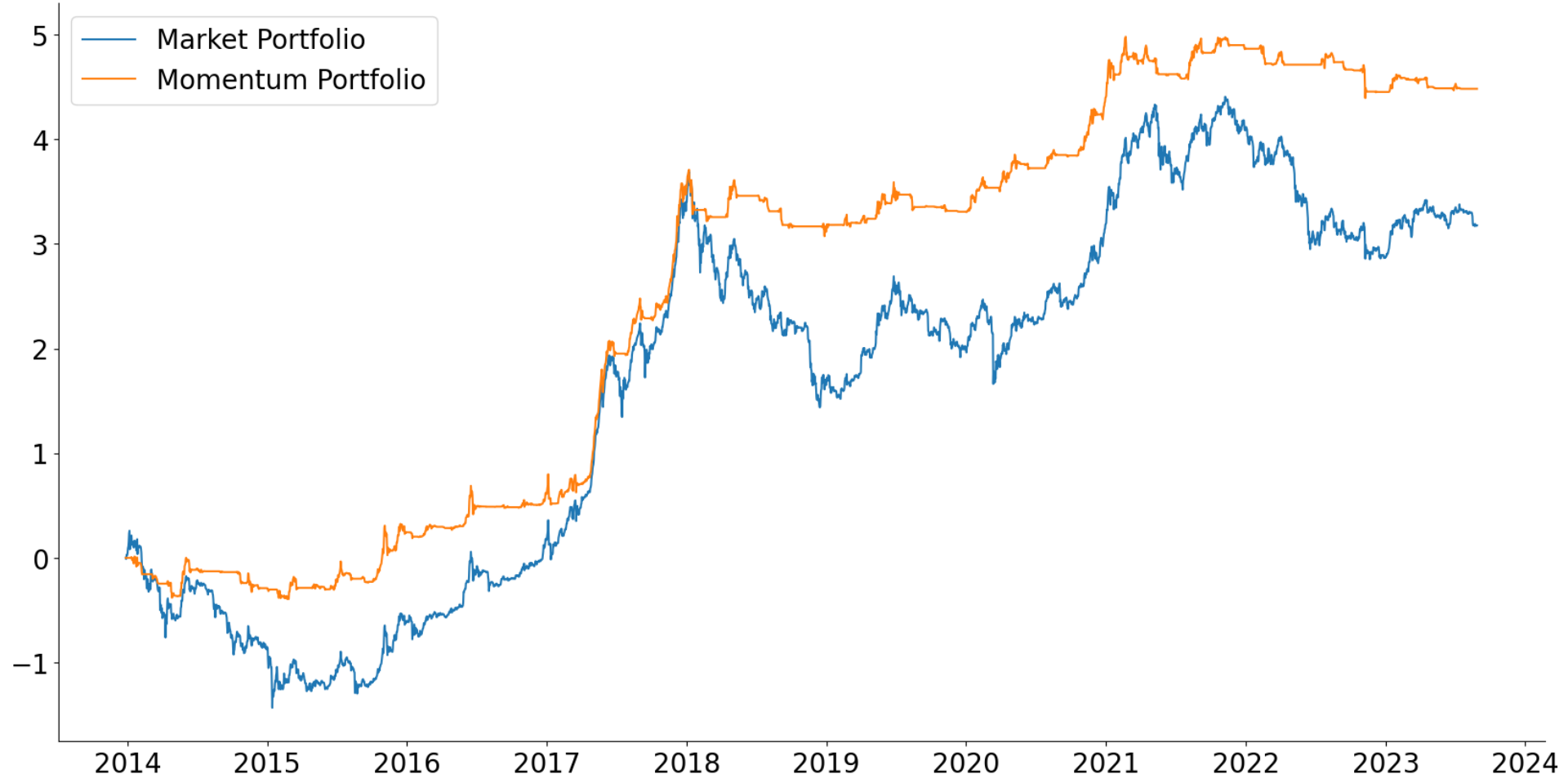
- Time-series momentum is applied on cryptocurrency market portfolio not for individual coins
- Day of week return anomaly in crypto market reported by Caporale et al. (2019) is adjusted
- In cross sectional momentum portfolios, both cross margin and isolated margin are tested
- Portfolio values are calculated with daily mark-to-market method

Time-series momentum portfolio performance

	L					S					LS				
(j, k)	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
(7, 1)	50.39	43.73	1.15	5096.1	56.2	-20.66	47.89	-0.43	95.5	96.7	31.88	64.80	0.49	190.2	80.9
(7, 3)	52.51	48.27	1.09	5108.0	63.2	-12.01	51.01	-0.24	91.0	95.3	48.89	68.46	0.71	1092.7	73.3
(7, 5)	50.22	52.81	0.95	3144.8	77.6	-19.07	54.54	-0.35	96.2	97.6	26.08	70.29	0.37	9.9	94.5
(7, 7)	45.12	54.81	0.82	1675.0	81.7	-14.85	53.78	-0.28	94.0	96.7	21.61	70.28	0.31	-28.5	91.6
(7, 14)	66.56	60.86	1.09	9989.0	79.9	-31.31	61.19	-0.51	99.2	99.6	53.65	72.86	0.74	1241.0	94.3
(14, 1)	51.98	45.48	1.14	5463.8	54.1	-5.25	48.77	-0.11	80.7	86.9	47.73	66.43	0.72	1100.3	60.4
(14, 3)	57.12	47.98	1.19	8065.2	54.9	-6.09	49.36	-0.12	82.7	88.3	53.12	67.97	0.78	1738.3	71.5
(14, 5)	60.98	49.36	1.24	1009.8	58.2	-4.49	50.09	-0.09	80.8	86.9	59.66	68.34	0.87	3252.3	61.0
(14, 7)	64.11	50.62	1.27	4025.6	56.6	-10.60	52.34	-0.20	90.4	95.0	67.35	69.10	0.97	6654.9	72.6
(14, 14)	50.61	56.25	0.90	2742.5	73.3	-1.96	30.90	-0.06	47.5	74.3	27.50	71.44	0.38	17.8	96.2
(21, 1)	54.90	45.28	1.21	7343.6	60.4	-2.61	48.11	-0.05	74.5	85.3	52.49	65.46	0.80	1911.2	63.7
(21, 3)	56.23	47.78	1.18	7470.8	60.1	1.78	48.74	0.04	62.1	81.6	59.83	67.31	0.89	3546.5	65.4
(21, 5)	46.72	49.54	0.94	2648.3	69.0	7.10	49.53	0.14	38.8	73.6	45.97	68.36	0.67	779.4	80.4
(21, 7)	48.13	51.57	0.93	2756.5	71.8	10.37	49.10	0.21	14.8	73.8	47.29	69.18	0.68	840.7	81.8
(21, 14)	56.84	54.75	1.04	5504.3	77.7	-6.82	53.62	-0.13	87.2	95.2	60.24	71.10	0.85	2790.4	88.9
(28, 1)	65.04	45.00	1.45	9991.6	63.5	-8.78	47.19	-0.19	85.4	90.9	56.63	64.72	0.88	3031.6	64.5
(28, 3)	65.39	47.17	1.39	8782.8	61.9	-3.66	47.68	-0.08	76.6	87.7	61.40	66.19	0.93	4438.9	65.0
(28, 5)	72.85	48.34	1.51	6685.8	61.8	-2.44	48.49	-0.05	74.8	88.9	72.17	67.27	1.07	1780.6	60.2
(28, 7)	71.71	48.28	1.49	2921.4	62.4	-0.02	48.95	0.00	68.6	82.1	73.50	67.55	1.09	3227.4	62.4
(28, 14)	64.60	54.12	1.19	2206.5	71.9	2.36	52.66	0.04	66.7	87.6	64.88	70.16	0.92	4790.0	82.6
Market											61.48	73.55	0.84	2481.4	89.2

(b) Performance of time-series momentum portfolio with transaction costs

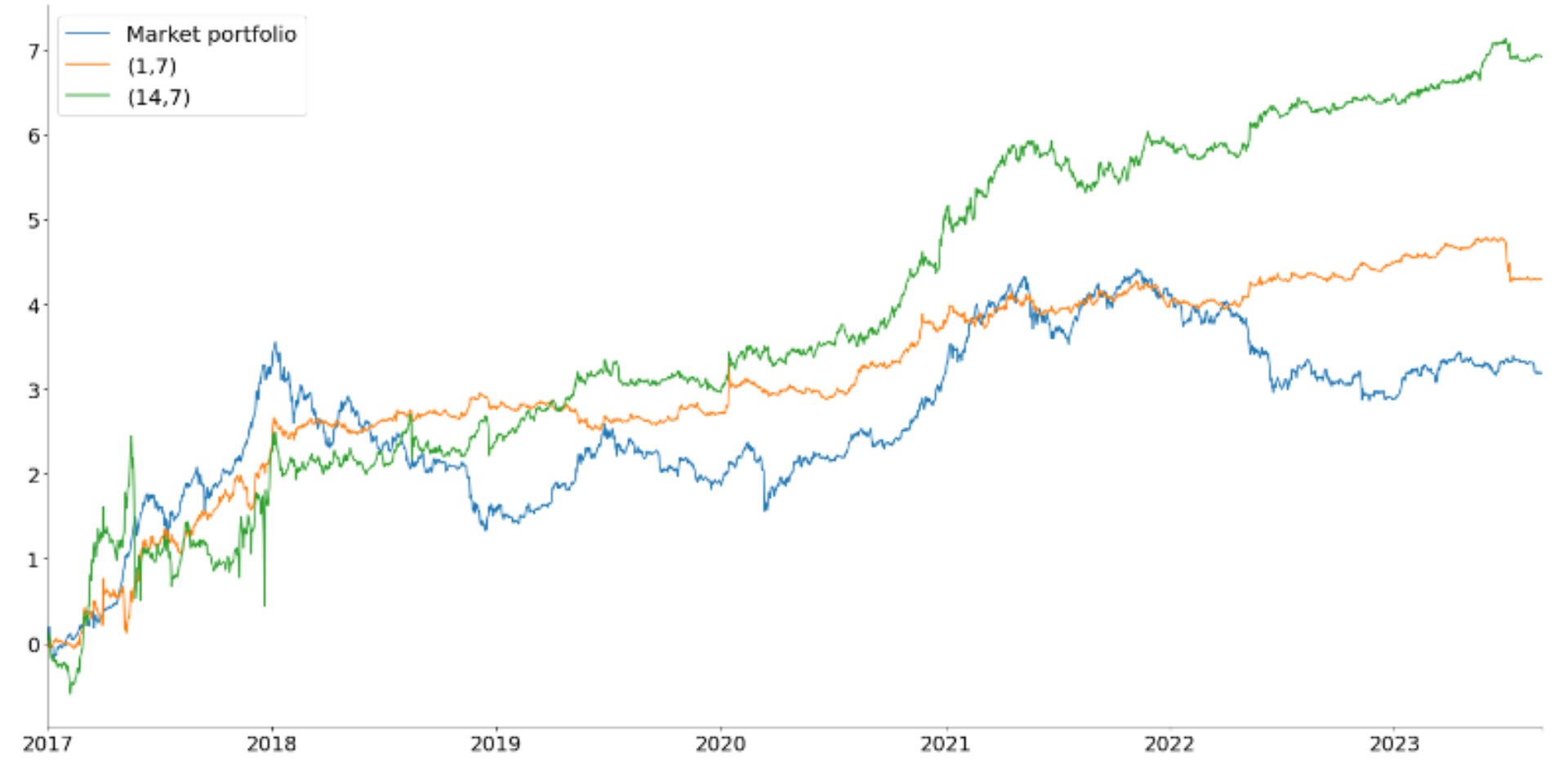
Time-series momentum portfolio performance – (28,5)



Cross-sectional momentum portfolio performance

	L					S					LS				
(j,k)	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
(1,7)	105.03	96.20	1.09	4830.9	95.6	-54.43	99.58	-0.55	-99.9	100.0	82.42	62.95	1.31	7227.1	47.3
(1,14)	107.21	95.85	1.12	5751.9	95.5	-78.02	108.92	-0.72	-100.0	100.0	49.18	61.55	0.80	687.6	62.8
(1,21)	101.21	94.41	1.07	4091.4	95.0	-1357.04	263.45	-5.15	-100.0	100.0	24.11	104.39	0.23	-87.2	99.1
(3,14)	106.11	95.02	1.12	5609.2	95.6	-734.00	198.59	-3.70	-100.0	100.0	39.36	76.10	0.52	90.9	97.5
(3,21)	84.12	93.32	0.90	1309.0	95.7	-577.53	361.17	-1.60	-100.0	100.0	-351.57	290.98	-1.21	-100.0	100.0
(3,28)	95.79	93.93	1.02	2913.1	94.4	-658.42	235.38	-2.80	-100.0	100.0	3.52	328.68	0.01	-100.0	100.0
(5,14)	119.89	103.52	1.16	9696.5	95.7	-62.30	121.70	-0.51	-100.0	100.0	108.66	93.52	1.16	6359.1	91.5
(5,21)	106.98	101.44	1.05	4371.4	94.1	38.12	899.16	0.04	-100.0	100.0	194.01	366.65	0.53	-100.0	100.0
(5,28)	104.48	102.79	1.02	3452.8	94.4	-698.21	218.38	-3.20	-100.0	100.0	94.18	220.08	0.43	-100.0	100.0
(7,14)	135.35	113.83	1.19	17485.2	95.9	-9.50	117.64	-0.08	-99.7	100.0	110.19	101.45	1.09	7758.8	89.9
(7,21)	117.74	113.45	1.04	5288.1	94.6	-997.99	222.40	-4.49	-100.0	100.0	72.74	118.07	0.62	68.4	97.7
(7,28)	117.47	113.91	1.03	5073.3	95.1	-636.56	252.14	-2.52	-100.0	100.0	126.56	292.82	0.43	-100.0	100.0
(14,5)	164.99	108.84	1.52	126039.6	93.3	36.81	180.60	0.20	-99.2	99.9	181.03	147.31	1.23	93788.6	92.1
(14,7)	149.95	105.74	1.42	55166.6	93.9	77.73	231.28	0.34	-99.2	99.9	174.73	136.93	1.28	101218.3	86.5
(14,14)	125.43	103.35	1.21	12736.2	94.6	-534.08	237.92	-2.24	-100.0	100.0	146.57	162.83	0.90	4553.6	96.6
(21,3)	150.40	109.26	1.38	45749.4	95.2	-41.68	109.11	-0.38	-99.9	100.0	104.40	102.25	1.02	3304.4	90.9
(21,5)	129.52	106.14	1.22	13904.9	95.5	-48.24	114.62	-0.42	-100.0	100.0	103.39	110.37	0.94	1870.3	95.7
(21,7)	116.23	104.41	1.11	6302.3	95.3	-581.68	257.71	-2.26	-100.0	100.0	79.07	112.00	0.71	147.3	98.5
(28,3)	121.62	108.25	1.12	6987.8	94.3	-63.04	107.82	-0.58	-100.0	100.0	57.98	98.06	0.59	87.4	95.9
(28,5)	113.67	105.60	1.08	4806.5	94.3	-51.96	115.73	-0.45	-100.0	100.0	62.38	97.77	0.64	163.5	96.0
(28,7)	97.38	104.08	0.94	1704.0	94.4	-41.58	122.00	-0.34	-100.0	100.0	41.32	97.29	0.42	-37.7	97.9
Market											78.60	77.79	1.01	2292.9	89.2

Cross-sectional momentum portfolio performance – (1,7), (14,7)



Portfolio performance analysis

Time-series

- Outperforms the market, stair-like shape suggests it successfully avoids drawdowns
- Regression model does not perfectly consistent with portfolio performance with transaction cost (without transaction cost portfolio shows more consistent result)
- Concentrated in bull market

Cross-sectional

- Enormous risk is inherent (especially in short position)
- Regression model suggests reversal, but reversal is not profitable
- Concentrated in big coins rather than small coins

Further Analysis

1) Market state dependency of momentum – transition matrix and regression

2) Factor regression – cryptocurrency 3-factor model by Liu et al. (2022)

3) Size dependency of momentum – double sorting momentum portfolio

4) Origin of momentum –behavior approach with CO measure by Byun et al. (2016)

5) Cross-margin vs. isolated margin

Factor regression

Market – market excess return

Size – market capitalization (small – big)

Momentum – cross-sectional momentum (21 days of lookback)

CS-CO – cross-sectional continuing overreaction

TS-CO – time-series continuing overreaction

$$CO_{i,t} = \frac{\sum_{j=1}^{J}(J-j+1)\cdot sign(r_{i,t-j})\cdot Vol_{i,t-j}}{\sum_{j=1}^{J} Vol_{i,t-j}/J}$$

Suggested by Byun (2016) based on the DHS model by Daniel et al. (1998)

Factor regression – Time series

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Const	0.0024	0.0029	0.0029	0.0028	0.0010	0.0024	0.0024	0.0024	0.0012
	(3.34)	(3.64)	(3.59)	(3.53)	(1.38)	(3.34)	(3.28)	(3.26)	(1.48)
MKT	0.0606					0.0615	0.0615	0.0604	0.0163
	(5.43)					(5.37)	(5.38)	(5.36)	(1.24)
SIZE		-0.0010				-0.0078	-0.0083	-0.0094	-0.0063
		(-0.08)				(-0.70)	(-0.74)	(-0.77)	(-0.53)
MOM			0.0019				0.0017	0.0010	-0.0028
			(0.33)				(0.33)	(0.22)	(-0.58)
CS-CO				0.0215				0.0050	0.0021
				(2.38)				(0.48)	(0.20)
TS-CO					0.1180				0.1009
					(6.52)				(4.06)
Adj R^2	0.057	0.000	0.000	0.005	0.088	0.057	0.057	0.057	0.090

This table reports the factor regression results of the (28, 5) long-only time-series momentum portfolio. The factors are market (MKT), size (SIZE), momentum (MOM), cross-sectional continuing overreaction (CS-CO), and time-series continuing overreaction (TS-CO). The sample period is from December 28, 2013 to August 28, 2023. The t-statistics are Newey-West adjusted t-statistics

Factor regression – Cross section

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Const	0.0295	0.0304	0.0234	0.0198	0.0221	0.0293	0.0223	0.0166	0.0127
	(4.29)	(4.38)	(3.86)	(3.06)	(3.37)	(4.44)	(4.34)	(3.05)	(2.39)
MKT	0.0923					0.0805	0.0838	0.0329	-0.0731
	(1.31)					(1.22)	(1.49)	(0.68)	(-1.28)
SIZE		0.0899				0.0745	-0.0761	-0.1158	-0.1060
		(0.65)				(0.54)	(-0.65)	(-0.99)	(-0.87)
MOM			0.3432				0.3548	0.2286	0.2207
			(1.49)				(1.53)	(1.59)	(1.57)
CS-CO				0.8510				0.7178	0.7001
				(7.92)				(4.75)	(4.70)
TS-CO					0.3298				0.2184
					(2.78)				(1.68)
Adj R^2	0.000	0.003	0.116	0.200	0.024	0.006	0.120	0.242	0.247

This table reports the factor regression results of the (14, 7) long-short cross-sectional momentum portfolfio. The factors are market (MKT), size (SIZE), momentum (MOM), cross-sectional continuing overreaction (CS-CO), and time-series continuing overreaction (TS-CO). 2.2. The sample period is from January 1, 2017 to August 28, 2023. The t-statistics are Newey-West adjusted t-statistics.

Double sorting

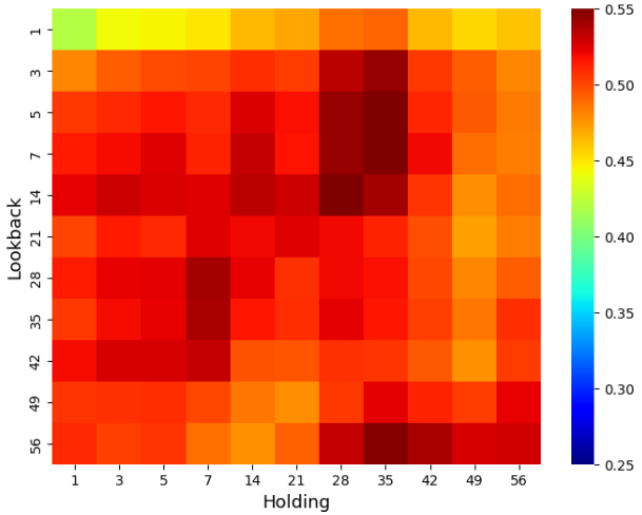
Time-series

	Buy-and-hold					Time-series momentum				
Group	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
M1	86.89	105.49	0.82	784.8	98.2	129.45	79.38	1.63	73197.2	73.7
M2	93.87	99.69	0.94	1732.6	97.8	125.58	74.30	1.69	68499.6	77.0
M3	75.30	98.64	0.76	563.7	98.3	104.47	67.26	1.55	23239.9	78.5
M4	101.91	108.95	0.94	2039.0	96.8	147.20	90.67	1.62	166677.5	77.0
M5	77.68	77.56	1.00	2278.6	88.9	80.00	49.53	1.62	8988.9	61.6

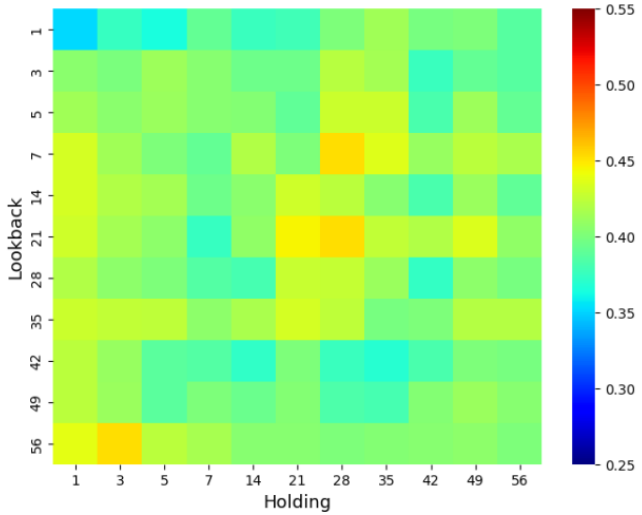
Cross-section

	L					S					LS				
Group	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
M1	7.62	125.92	0.06	-97.5	99.7	35.53	105.82	0.34	-74.0	98.4	35.36	98.69	0.36	-47.8	97.1
M2	34.63	105.34	0.33	-71.3	98.6	-22.28	108.44	-0.21	-99.2	99.5	35.36	82.91	0.43	7.3	93.8
M3	-0.42	98.89	-0.00	-94.4	99.1	-2.10	98.25	-0.02	-94.5	97.3	18.70	70.26	0.27	-27.7	89.0
M4	40.32	101.85	0.40	-49.6	98.4	5.58	97.52	0.06	-91.1	97.3	60.28	67.21	0.90	803.3	76.9
M5	84.36	98.53	0.86	704.4	94.6	3.28	101.43	0.03	-94.6	98.9	91.18	78.59	1.16	3171.2	68.3
Market											40.66	76.65	0.53	83.5	89.1

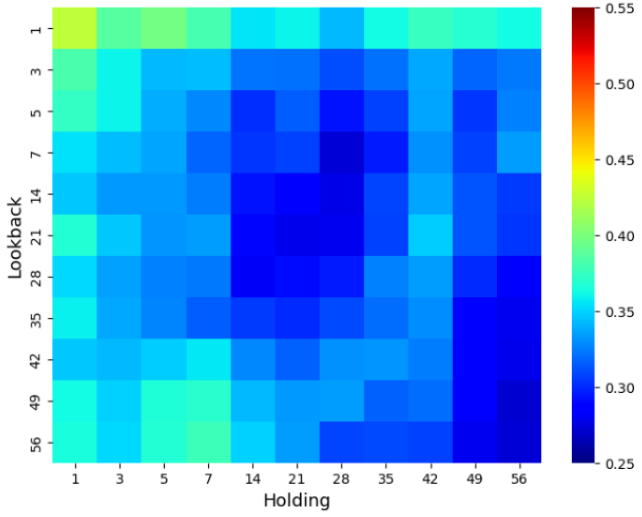
Market dependency – Time series



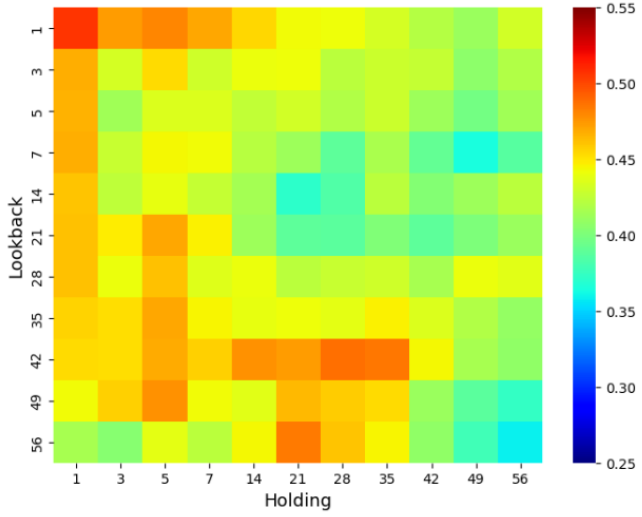
(a) Q5 → Q4,Q5



(b) Q1 → Q1,Q2

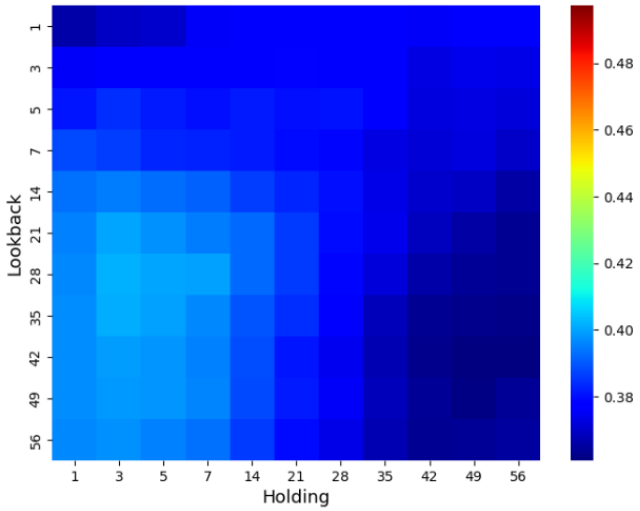


(c) Q5 → Q1,Q2

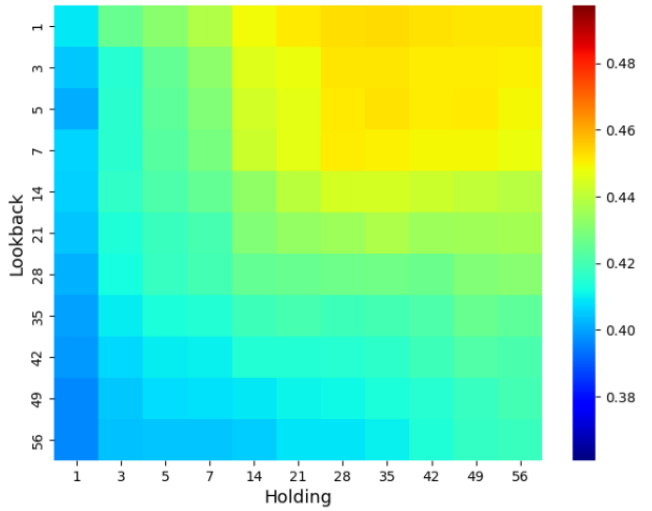


(d) Q1 → Q4,Q5

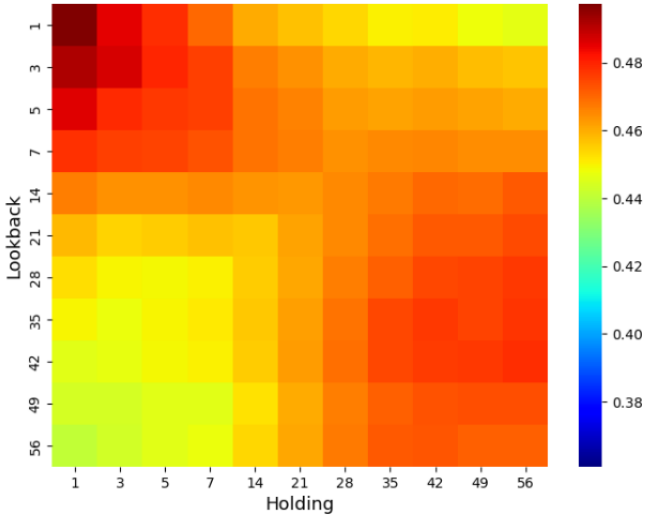
Market dependency – Cross section (All)



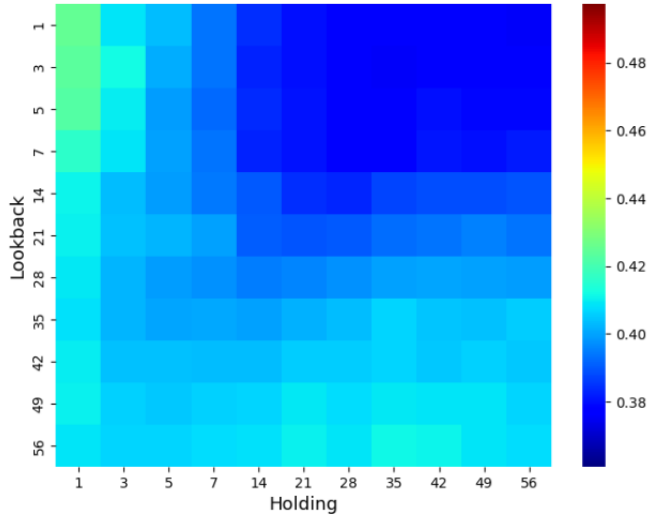
(a) Q5 → Q4,Q5



(b) Q1 → Q1,Q2

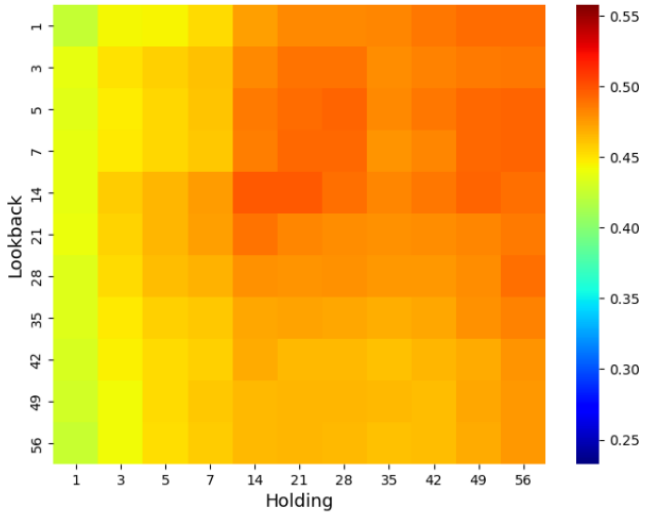


(c) Q5 → Q1,Q2

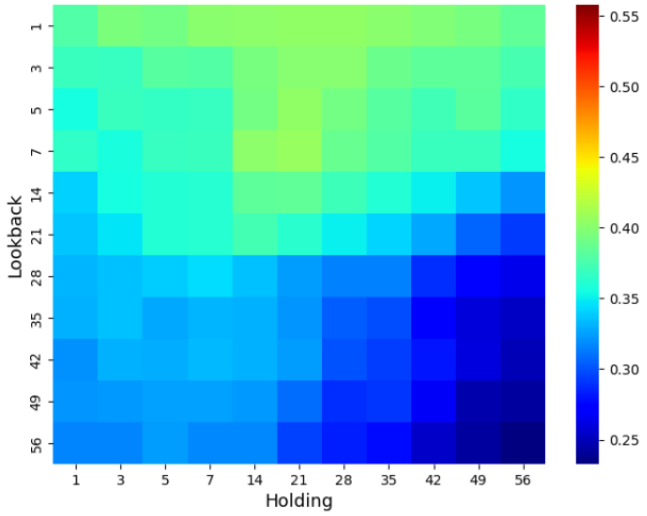


(d) Q1 → Q4,Q5

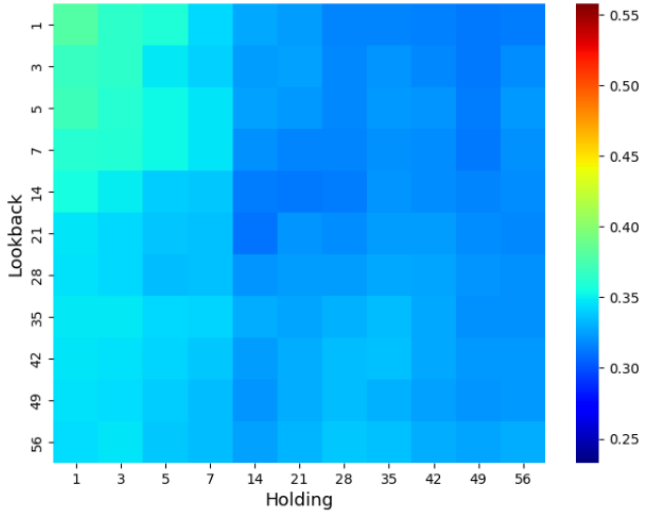
Market dependency – Cross section (top 5%)



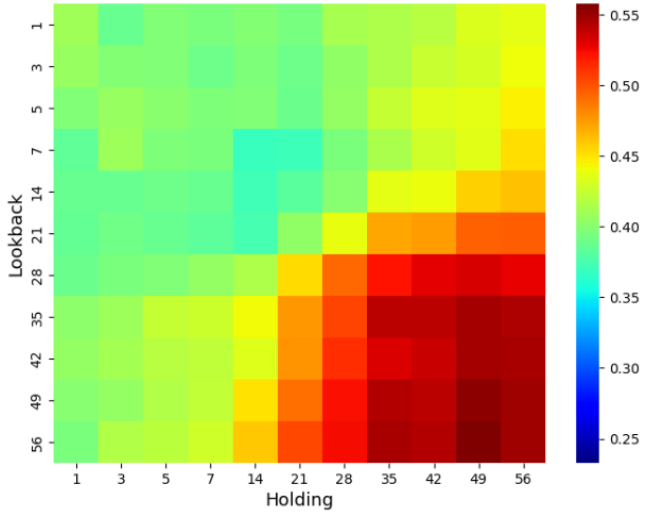
(a) Q5 → Q4,Q5



(b) Q1 → Q1,Q2



(c) Q5 → Q1,Q2



(d) Q1 → Q4,Q5

Double sorting

Time-series

	Buy-and-hold					Time-series momentum				
Group	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
M1	86.89	105.49	0.82	784.8	98.2	129.45	79.38	1.63	73197.2	73.7
M2	93.87	99.69	0.94	1732.6	97.8	125.58	74.30	1.69	68499.6	77.0
M3	75.30	98.64	0.76	563.7	98.3	104.47	67.26	1.55	23239.9	78.5
M4	101.91	108.95	0.94	2039.0	96.8	147.20	90.67	1.62	166677.5	77.0
M5	77.68	77.56	1.00	2278.6	88.9	80.00	49.53	1.62	8988.9	61.6

Cross-section

	L					S					LS				
Group	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD	Mean	Std	Sharpe	Cum	MDD
M1	7.62	125.92	0.06	-97.5	99.7	35.53	105.82	0.34	-74.0	98.4	35.36	98.69	0.36	-47.8	97.1
M2	34.63	105.34	0.33	-71.3	98.6	-22.28	108.44	-0.21	-99.2	99.5	35.36	82.91	0.43	7.3	93.8
M3	-0.42	98.89	-0.00	-94.4	99.1	-2.10	98.25	-0.02	-94.5	97.3	18.70	70.26	0.27	-27.7	89.0
M4	40.32	101.85	0.40	-49.6	98.4	5.58	97.52	0.06	-91.1	97.3	60.28	67.21	0.90	803.3	76.9
M5	84.36	98.53	0.86	704.4	94.6	3.28	101.43	0.03	-94.6	98.9	91.18	78.59	1.16	3171.2	68.3
Market											40.66	76.65	0.53	83.5	89.1

Reference

Asness, C. S., Moskowitz, T. J., & Pedersen, L. H. (2013). Value and momentum everywhere. The Journal of Finance, 68(3), 929–985. DOI: 10.1111/jofi.12021

Byun, S. J., Lim, S. S., & Yun, S. H. (2016a). Continuing overreaction and stock return predictability. Journal of Financial and Quantitative Analysis, 51(6), 2015–2046. DOI: 10.1017/s0022109016000594

Caporale, G. M., & Plastun, A. (2019). The Day of the week effect in the cryptocurrency market. Finance Research Letters, 31. DOI: 10.1016/j.frl.2018.11.012

Daniel, K., Hirshleifer, D., Subrahmanyam, A., 1998. Investor psychology and security market under- and overreactions. The Journal of Finance 53

Grobys, K., & Sapkota, N. (2019). Cryptocurrencies and momentum. Economics Letters, 180, 6–10. https://doi.org/10.1016/j.econlet.2019.03.028

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for Stock Market Efficiency. The Journal of Finance, 48(1), 65–91. DOI: 10.1111/j.1540-6261.1993.tb04702.x

Jia, B., Goodell, J. W., & Shen, D. (2022). Momentum or reversal: Which is the appropriate third factor for cryptocurrencies? Finance Research Letters, 45, DOI: 102139. https://doi.org/10.1016/j.frl.2021.102139

Lim, B. Y., Wang, J. (George), & Yao, Y. (2018). Time-series momentum in nearly 100 years of stock returns. Journal of Banking & Finance, 97, 283–296. DOI: 10.1016/j.jbankfin.2018.10.010

Liu, Y., & Tsyvinski, A. (2020). Risks and returns of cryptocurrency. The Review of Financial Studies, 34(6), 2689–2727. DOI: 10.1093/rfs/hhaa113

Liu, Y., Tsyvinski, A., & Wu, X. (2022). Common risk factors in cryptocurrency. The Journal of Finance, 77(2), 1133–1177. DOI: 10.1111/jofi.13119

Moskowitz, T. J., Ooi, Y. H., & Pedersen, L. H. (2012). Time Series Momentum. Journal of Financial Economics, 104(2), 228–250. DOI: 10.1016/j.jfineco.2011.11.003

Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3), 703. DOI: 10.2307/1913610

Tzouvanas, P., Kizys, R., & Tsend-Ayush, B. (2020). Momentum trading in cryptocurrencies: Short-term returns and diversification benefits. Economics Letters, 191, 108728. DOI: https://doi.org/10.1016/j.econlet.2019.108728

Zaremba, A., Bilgin, M. H., Long, H., Mercik, A., & Szczygielski, J. J. (2021). Up or down? short-term reversal, momentum, and liquidity effects in cryptocurrency markets. International Review of Financial Analysis, *78*, 101908. https://doi.org/10.1016/j.irfa.2021.101908