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Sentiment in the Cross Section of Cryptocurrency Returns

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Crypto Market Overview

- Satoshi Nakamoto (2008) proposed the first decentralized peer-to-peer payment network – the prototype of the Bitcoin blockchain system.

- A blockchain is an electronic ledger that records transactions in discrete chunks called blocks. All blocks are chained together in a particular order (a blockchain).

- Ethereum (2013) is the first blockchain which support smart contracts proposed by Nick Szabo (1994).Besides the fundamental cryptos, ERC-20 tokens experienced a boom after 2016.

- Cryptocurrencies, worth over US$2 trillion, has emerged as a new asset class

Crypto Market Overview – Continued

- We plot the accumulated wealth if invested $1 in 2014.
- Cryptocurrency market return (CMKT) is calculated as the value-weighted return of all underlying available coins in orange.
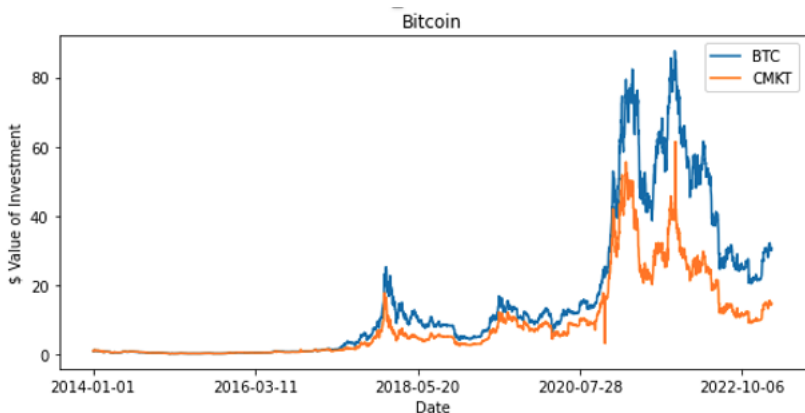
Known Anomalies in Cryptocurrency Market

- Liu, Tsyvinski, and Wu (2022) specifies ten significant long-short strategy returns, which cannot fully be explained by cryptocurrency market factor alone (Crypto CAPM).

- They propose a three factor model comprise of **market, size, and momentum** factors that best explains the cross-sectional variation of cryptocurrency market returns.

Evidence of Sentiment Influences Equity Market

- Baker and Wurgler (2006) construct macroeconomic sentiment and find sentiment has significant impact for stocks which are hard to be priced.

- Kumar and Lee (2006) use buy-sell imbalance to construct a sentiment factor to explain the anomaly in Baker and Wurgler (2006).

- Frazzini and Lamont (2008) use mutual fund flows as a measure of sentiment, and find that high sentiment predicts low future return.

- Some recent sentiment works are focus on social media and echo chambers (Cookson, Engelberg, and Mullins,2023), retailed investors sentiment (Hu, Jones, Zhang, and Zhang, 2023)...

Current Evidence of Sentiment on Cryptocurrency Market

- In April 2021, Coinbase went public on NASDAQ, which led the market sharply rise for almost 1 month.

- In May 2021, the meme crypto Dogecoin had increased to 20,000% of value in one year. It then dropped 35% of its value over a weekend after Elon Musk's announcement that Tesla would suspend using bitcoin as payment method.

- In November 2022, the collapse of third-largest crypto exchange FTX had a wide impact on crypto market. The most famous stable coin USDT dropped below its peg price $0.97 and Bitcoin sank to its lowest price in two years.

Summary of Results

- We construct an representative cryptocurrency market sentiment index denoted as *CryptoSent*.

- We find that cryptocurrencies with high sensitivity to the change of *CryptoSent* have significant lower average returns in the following month and week.

- We introduce sentiment factor as a common risk factor to explain the cross-sectional returns of cryptocurrencies.

- The four-factor model explains an additional 13% of the of the weekly expected cryptocurrency returns.

- The sentiment factor possesses both economic and statistical significance in explaining eleven cryptocurrency characteristics-based long-short strategies.

Cryptocurrency Price Data

- Cryptocurrency data comes from web scraping of cryptocurrency daily snapshot from CoinMarketCap.

- Our data set includes more than 2,900 different cryptocurrencies (native cryptos and ERC-20 tokens).

- We keep cryptocurrencies with market capitalization over $100,000 to address the illiquidity issues for less traded tokens.

Cryptocurrency Sentiment Data

- Searching engine attention about cryptocurrency is obtained from Google Search. Google trend data is scaled to have daily frequency.

- Daily tweets on X (formerly Twitter) count with keywords, e.g. "Bitcoin", "Ethereum"...

- Daily active (public) wallet addresses in Bitcoin and Ethereum blockchain network.

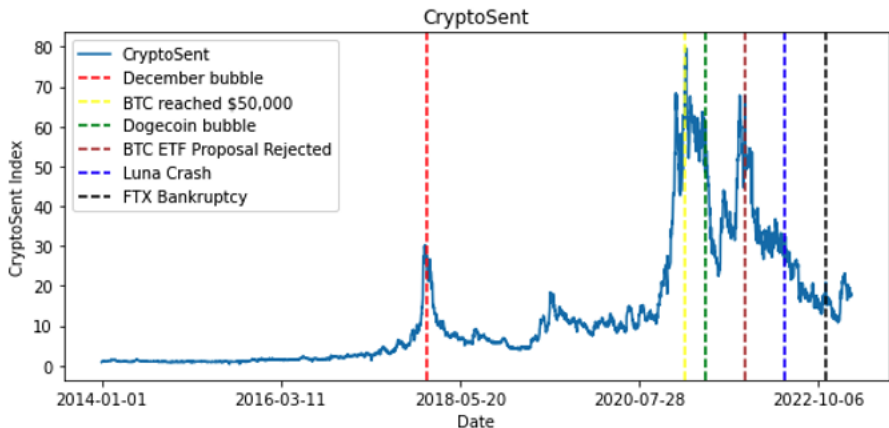# Cryptocurrency Market Sentiment Index Construction

- We construct the crypto market sentiment index, *CryptoSent*, following the method of Baker and Wurgler (2006). This procedure results in the index:

$CryptoSent_t = 0.4090 \times Crypto\ Index_{t-1} + 0.2698 \times Google\ Trend_t + 0.3755 \times \#Tweet_{t-1} + 0.3731 \times Volatility_t + 0.3880 \times Volume_{t-1} + 0.3814 \times \#Wallet_t + 0.3448 \times Blockchain\ Transcations_{t-1} + 0.2540 \times \#ICO_t$

Our CryptoSent encompasses cryptocurrency market index, market volatility, market volume, google trends of "cryptocurrency", tweets discussion, the number of active wallets on blockchain, initial coin offerings on the Ethereum blockchain, and blockchain transactions.

CryptoSent and Main Cryptocurrency Market Events

- The constructed *CryptoSent* captures major cryptocurrency market shocks.

Cryptocurrencies' Exposures on Market Sentiment

- To eliminate the trend of the market sentiment, and capture the sentiment change. We use the first-difference, $\Delta CryptoSent_t$ to capture the daily market sentiment.

- Following Ang, Hodrick, Xing, and Zhang (2006), we use $\beta^i_{\Delta CryptoSent}$ to proxy their exposures.

  $r^i_t - r^f_t =$
  $\beta_0 + \beta^i_{CMKT} \times CMKT_t + \beta^i_{\Delta CryptoSent} \times \Delta CryptoSent_t + \epsilon^i_t.$

- We define unsigned value $|\beta^i_{\Delta CryptoSent}|$ from past 4-week data as the sensitivity of token i to market sentiment.

Sentiment-related Anomaly

- Each week, we sort all tokens based on $|\beta^i_{\Delta CryptoSent}|$ and group them into quintiles, and match their respective returns in the following week and subsequent month.

Panel A. Sentiment Strategy Weekly Excess Return						
	Quintiles					
	1	2	3	4	5	5-1
$|\beta^i_{\Delta CryptoSent}|$	**Low**				**High**	
Mean	-0.002	-0.001	0.002	-0.003	-0.026	-0.025
t(mean)	(-0.33)	(-0.11)	(0.25)	(-0.37)	(-3.53)***	(-3.75)***
Panel B. Sentiment Strategy Monthly (4-week) Excess Return						
	Quintiles					
	1	2	3	4	5	5-1
$|\beta^i_{\Delta CryptoSent}|$	**Low**				**High**	
Mean	0.052	0.065	0.063	0.061	0.001	-0.051
t(mean)	(3.85)***	(3.28)***	(2.56)**	(2.58)**	(0.05)	(-3.28)***

Can Sentiment-related Anomaly Be Explained by 3-factor Model?

- Following Liu, Tsyvinski, and Wu (2022), we analyze the zero-investment long-short strategy based on the sentiment-related characteristics of $|\beta^i_{\Delta CryptoSent}|$. We denote sentiment-related anomaly we found previously as $|BETASENT|$.

- $R_t^{|BETASENT|} - R_t^f =$
  $\alpha + \beta_{CMKT} \times CMKT_t + \beta_{size} \times CSMB_t + \beta_{momentum} \times CMOM_t + \epsilon_t.$

  Where $CSMB$ and $CMOM$ are size and momentum factor introduced in Liu, Tsyvinski, and Wu (2022).

Strategy	Model	Cons	Cons t	CMKT	CMKT t	CSMB	CSMB t	CMOM	CMOM t	CSTM	CSTM t	R²	M.A.E
$|\beta_{SENT}|$	1	-0.024	(-3.57)***	-0.068	(-1.33)	0.018	(0.41)					0.004	0.095
	2	-0.025	(-3.62)***	-0.066	(-1.3)			0.025	(0.62)			0.005	0.096

- The excess return of $|BETASENT|$ can not be explained by these factors.

Concentration of Sentiment-sensitive Cryptos

- In stocks market, sentiment-related stocks are concentrated in hard-pricing stocks, e.g. small stocks, growth stocks, stocks with more retailed investors (Stambaugh, Yu, and Yuan (2012), Baker and Wurgler (2006)).

- In cryptocurrency market, the concentration effects also exist.

Panel C. Momentum Quintiles' Weighted Average Exposures on Sentiment $|\beta^i_{\Delta CryptoSent}|$

	Quintiles				
	1	2	3	4	5
R 3,0	Low				High
Mean	0.21	0.11	0.009	0.089	0.210

Panel C. Size Quintiles' Weighted Average Exposures on Sentiment $|\beta^i_{\Delta CryptoSent}|$

	Quintiles				
	1	2	3	4	5
MCAP	Low				High
Mean	0.289	0.287	0.262	0.225	0.050

- Sentiment-sensitive cryptos are concentrated in small-size cryptos, large-return cryptos and large-loss cryptos.

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Three-factor model for 25 value-weight Momentum-$|BETASENT|$ Portfolios.

- Following the FF-5 factor model (Fama and French, 2015), we allocate cryptocurrencies independently into 5 momentum-quintiles and 5 $|\beta_{\Delta CryptoSent}|$-quintiles.

- We then test whether 3-factor model can explain the excess return of portfolios.

Regressions for 5*5 value-weight Sentiment-Momentum portfolios										
Momentum →	Low	2	3	4	High	Low	2	3	4	High
Panel A: Three-factor (CMKT, CSMB, CMOM) regression intercepts										
$R(t) - R_f(t) = \alpha + \beta_{cmkt}CMKT + \beta_{size}CSMB + \beta_{momentum}CMOM + e(t)$										
Sentiment ↓			α					$t(\alpha)$		
Neutral	-0.020	-0.009	-0.003	0.008	0.005	-3.171	-1.587	-0.704	1.359	0.370
2	-0.007	-0.008	-0.005	0.006	0.004	-0.812	-1.329	-0.901	0.584	0.361
3	-0.014	-0.011	0.002	-0.003	0.010	-2.045	-1.554	0.248	-0.463	1.168
4	-0.008	0.014	-0.005	0.004	0.006	-1.062	0.770	-0.766	0.549	0.689
Sensitive	-0.011	0.004	-0.018	-0.007	-0.018	-1.152	0.341	-2.235	-0.844	-1.723

- Three-factor model suffers when explaining highlighted corner portfolios.

The Sentiment Factor Construction

- Three-factor model can not explain sentiment-related anomaly.

- Three-factor model also suffers when portfolios has concentration of sentiment-sensitive cryptos.

- We propose a four-factor model that incorporates the sentiment factor.

- We construct factors using the 6 (2×3) value-weight portfolios formed on $|\beta_{\Delta CryptoSent}|$ and size, the 6 (2×3) value-weight portfolios formed on $|\beta_{\Delta CryptoSent}|$ and momentum.

The Sentiment Factor Construction – Continued

- $CSTM_{size} =$
  $1/3(SensitiveSmall + SensitiveMedium + SensitiveBig) -$
  $1/3(NeutralSmall + NeutralMedium + NeutralBig),$

  $CSTM_{momentum} =$
  $1/3(SensitiveLow + SensitiveMedium + SensitiveHigh) -$
  $1/3(NeutralLow + NeutralMedium + NeutralHigh),$

  $CSTM = 1/2(CSTM_{size} + CSTM_{momentum}).$

- $CMOM = 1/2(NeutralHigh + SensitiveHigh) -$
  $1/2(NeutralLow + SensitiveLow).$

- $CSMB = 1/2(NeutralSmall + SensitiveSmall) -$
  $1/2(NeutralBig + SensitiveBig).$

Long-short Anomaly: Four-factor Model

- After adding sentiment factor, the excess return of $|BETASENT|$ can be fully explained by our four-factor model.

Strategy	Model	Cons	Cons t	CMKT	CMKT t	CSMB	CSMB t	CMOM	CMOM t	CSTM	CSTM t	R^2	M.A.E
$|\beta_{SENT}|$	1	-0.024	(-3.57)***	-0.068	(-1.33)	0.018	(0.41)					0.004	0.095
	2	-0.025	(-3.62)***	-0.066	(-1.3)			0.025	(0.62)			0.005	0.096
	3	-0.003	(-1.09)	-0.064	(-2.81)***					0.813	(43.19)***	0.800	0.039
	4	-0.025	(-3.63)***	-0.066	(-1.3)	0.02	(0.46)	0.027	(0.65)			0.005	0.096
	5	-0.003	(-0.81)	-0.067	(-2.94)***	0.019	(1.00)	-0.042	(-2.29)**	0.816	(43.44)***	0.803	0.040

- We confirm that other long-short anomalies can also be explained under our four-factor model.

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Four-factor model on 25 value-weight Momentum – $|BETASENT|$ Portfolios

- Recall that 3-factor model is struggled in corner portfolios due to the concentration effect. We show that our 4-factor model can resolve the issue.

	Regressions for 5*5 value-weight Sentiment-Momentum portfolios									
Momentum →	Low	2	3	4	High	Low	2	3	4	High
Panel A: Three-factor (CMKT, CSMB, CMOM) regression intercepts										
$R(t) - R_f(t) = \alpha + \beta_{cmkt}CMKT + \beta_{size}CSMB + \beta_{momentum}CMOM + e(t)$										
Sentiment ↓			α					$t(\alpha)$		
Neutral	-0.020	-0.009	-0.003	0.008	0.005	-3.171	-1.587	-0.704	1.359	0.370
2	-0.007	-0.008	-0.005	0.006	0.004	-0.812	-1.329	-0.901	0.584	0.361
3	-0.014	-0.011	0.002	-0.003	0.010	-2.045	-1.554	0.248	-0.463	1.168
4	-0.008	0.014	-0.005	0.004	0.010	-1.062	0.770	-0.766	0.549	0.689
Sensitive	-0.011	0.004	-0.018	-0.007	-0.018	-1.152	0.341	-2.235	-0.844	-1.723
Panel B: Four-factor model regression										
$R(t) - R_f(t) = \alpha + \beta_{sentiment}CSTM + \beta_{cmkt}CMKT + \beta_{size}CSMB + \beta_{momentum}CMOM + e(t)$										
Sentiment ↓			α					$t(\alpha)$		
Neutral	-0.017	-0.007	-0.001	0.009	0.010	-2.693	-1.291	-0.228	1.466	0.810
2	-0.004	-0.006	-0.003	0.009	0.007	-0.457	-0.931	-0.567	0.924	0.657
3	-0.010	-0.007	0.005	-0.001	0.015	-1.376	-1.026	0.568	-0.090	1.705
4	0.000	0.021	-0.001	0.006	0.010	0.005	1.084	-0.128	0.745	1.093
Sensitive	-0.004	0.012	-0.015	-0.001	-0.003	-0.393	0.995	-1.879	-0.090	-0.326

- We confirm the 4-factor model can mitigate the corner issue in 25 value-weight Size-$|BETASENT|$ Portfolios.

Four-factor model on 25 value-weight Momentum – $|BETASENT|$ Portfolios – Continued

- The 4-factor model explains an additional 13% of the return variations on average for 5×5 portfolios.

Regressions for 5*5 value-weight Sentiment-Momentum portfolios

Momentum →	Low	2	3	4	High	Low	2	3	4	High
Panel A: Three-factor (CMKT, CSMB, CMOM) regression intercepts $R(t) - R_f(t) = \alpha + \beta_{cmkt} \, CMKT + \beta_{size} \, CSMB + \beta_{momentum} \, CMOM + e(t)$										
Sentiment ↓			R^2					$S(e)$		
Neutral	0.358	0.302	0.453	0.354	0.191	0.131	0.117	0.092	0.118	0.260
2	0.316	0.369	0.436	0.239	0.223	0.178	0.126	0.113	0.203	0.210
3	0.387	0.307	0.272	0.298	0.249	0.146	0.142	0.163	0.144	0.183
4	0.256	0.079	0.334	0.279	0.280	0.164	0.386	0.129	0.155	0.179
Sensitive	0.221	0.155	0.226	0.193	0.219	0.189	0.238	0.160	0.172	0.215
Panel B: Four-factor model regression: $R(t) - R_f(t) = \alpha + \beta_{cmkt} \, CMKT + \beta_{sentiment} \, CSTM + \beta_{size} \, CSMB + \beta_{momentum} \, CMOM + e(t)$										
Sentiment ↓			R^2					$S(e)$		
Neutral	0.362	0.303	0.455	0.354	0.191	0.131	0.118	0.092	0.118	0.260
2	0.333	0.382	0.446	0.240	0.233	0.176	0.125	0.112	0.203	0.209
3	0.439	0.381	0.279	0.310	0.257	0.139	0.135	0.162	0.143	0.183
4	0.270	0.088	0.360	0.290	0.301	0.162	0.385	0.127	0.154	0.177
Sensitive	0.258	0.182	0.251	0.223	0.676	0.185	0.235	0.158	0.169	0.139

Fama-Macbeth Cross-Sectional Regression

- For each crypto, each of its characteristics ($\beta_{CMKT}, Size, Momentum, \& \ |\beta_{\Delta CryptoSent}|$) is first sorted into five quintiles at the end of each week. We use the rank numbers as explanatory variables.

Panel C: Multiple-Factor Model						
Model	Intercept	β_{CMKT}	$|\beta^i_{\Delta CryptoSent}|$	MCAP	R 3,0	$\bar{R}^2$
(10)	-0.029 (-2.27)	-0.001 (-0.27)		0.006 (2.47)	0.001 (1.11)	5.59%
(11)	-0.005 (-0.41)	-0.001 (-0.36)	-0.005 (-6.50)	0.003 (1.37)	0.002 (1.67)	7.11%

- The results show that the sentiment factor is crucial in explaining cryptocurrency cross-sectional return variations.

Conclusions

- In this paper, we construct an overall cryptocurrency market sentiment index.

- We find a sentiment-related anomaly cannot be explained by the current three-factor modelin cryptocurrency market.

- We propose a four-factor cryptocurrency model after adding the newly proposed sentiment factor.

- Our sentiment factor explains an additional 13% of the return variations in cross-sectional return of cryptocurrencies from 2014-2023.

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