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Good vibes only: The crypto-optimistic behavior

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ABSTRACT
This paper aims at investigating the relationship between news-driven sentiments and the convergence of behavior in cryptocurrencies market, contributing to the existing literature in the field. The novelty stands in the relation set between the tone of news and returns dispersion. The average daily sentiment score deriving from a worldwide online news dataset has been exploited as a proxy of market humor, in the attempt to identify how emotions spread by the press are related to traders’ actions. By employing both Cross-sectional standard (CSSD) and absolute (CSAD) deviation, it is found that the rises and falls of optimism shape returns variability. Indeed, the paper evidences how an increase of news positivity is associated with a lower returns dispersion, evidencing the convergence of beliefs among investors.

1. Introduction
Cryptocurrencies can be considered as the present and future challenges for both scholars and financial analysts. Besides their real contribution and potential application to the economic and financial system, different studies addressed their efforts in detecting the driving factors influencing their price dynamics. The main aim of the current letter is to explain the potential convergence of evaluation linked to news-driven investors’ sentiments.

Indeed, David Gerard (2018) stated that “Bitcoin is less about technology than psychology”, discussing how cryptos’ market dynamics can be influenced by traders’ humors and reactions. In this perspective, different papers investigated the performance of their market values, considering their price reaction to both positive and negative specific events (Feng et al., 2018; Vidal-Tomás and Ibañez, 2018; Al-Khazali et al., 2018) and the generation of bubbles or explosive dynamics (Cheah and Fry, 2015; Bouri et al., 2019b). Additional insights about investors’ sentiments and behavior can be offered by observing the herding behavior of these currencies. As widely known, herding refers to the imitation of the judgments of others while making decisions (Kumar and Goyal, 2015) leading to a synchronization of price co-movements of similar assets. Indeed, Christie and Huang (1995) suggested that in case of convergence of opinion, it can be observed a reduction of the variability of outcome, since beliefs converge to the prevailing market reaction. Historically, this pattern emerged during periods of financial turmoil – such as the 2008 crisis (see Humayun Kabir, 2018) – remarking the importance of studying how the herd instinct can driving asset prices in financial markets.

As discussed in Ballis and Drakos (2020), only few papers attempted to explain this phenomenon in cryptos’ market. Indeed, in addition to the work offered by the authors, empirical evidences can be found in Bouri et al. (2019b) and Vidal-Tomás et al. (2019), where the authors found that smallest cryptocurrencies are herding with the largest ones. As standard herding approach, different papers examine the relationship between the mean/variance relationship of returns (see Christie and Huang (1995) and Chiang and Zheng (2010) as pioneer studies). In these cases, herding happens if the variability of returns decreases for extremes (positive or negative) average values, since all the evaluations of assets head towards the same expectation. However, there are some other factors that might explain the convergence of behavior in cryptocurrencies market.

From here comes the need to further investigate such interesting pattern. The main idea is that media sentiments tone might shape investors humors, impacting price expectation. To clarify, investors might anchor Furnham and Boo (2011) their prediction to the information (sentiment) they receive (perceive). As stated in Song et al. (2017), media has a huge effect on financial market, and sometimes it drives significant market exercises. With regards to cryptocurrencies, Philippas et al. (2019) found that bitcoin prices are partially driven by media attention. These results have been also confirmed in the past by Kristoufek (2013) that examined the relationship between Bitcoin and search queries on Google Trends and Wikipedia. However, as discussed by the same author, a limitation of that work is the absence of a distinction between good/bad news. On this line a case study based on the individuation of some specific
positive/negative events to test the semi-strong efficiency of bit-
coins can be found in Vidal-Tomáš and Ibáñez (2018), while Bouri
et al. (2019a) found a relation between news about US growth
uncertainty and bitcoin price dynamics. However, more efforts
can be done following this direction, as discussed in Gurdgiev
and O’Loughlin (2020), where the same authors identified the
need to enrich the discussion on the relation between news and
bitcoin price. In particular, they stressed the importance of
introducing sentiment scores on a continuous scale to fully reflect
the intensity of investors reactions to news. The current work
aims at covering this gap. Indeed, Song et al. (2017) evidenced
how media articles can be categorized, on the basis of a lexicon-
based approach, in positive and negative announcements, even
detecting the positive/negative intensity of the information re-
leased Currently, literature lacks of paper analyzing the possible
relation between sentiments dynamics generated by the world-
wide online press on the convergence of investors’ behavior in
crypto market. Following Christie and Huang (1995) and Chang
and Zheng (2010), herding pattern is empirically investigated
in cryptocurrencies during the period analyzed.

2. Data and methodology

For the purpose of this letter, 730 daily observations from
the 01/01/2018 to the 01/01/2020 have been collected. Since
several papers discussed the impact of media during particular
explosive behavior (Philippas et al., 2019), the current work aims
at investigating how cryptocurrencies behave during the “quiet
after the storm”, even if such period does not exclude interesting
market fluctuations.1 In other words, it is checked whether,
during periods where no extreme events occur, it is possible to
identify regularities in cryptocurrencies' price dynamics. To this
extent, data have been collected moving from the period after
the burst and the peak of the 2017 bubble and without including
cryptos' behavior during COVID-19, since both of these periods
consider particular and extreme events.

Dataset on the basis of some selected keywords. In particu-
lar, the keyword “cryptocurrency” has been queried. The output
released offers the possibility to: (i) identify the daily media
coverage of the selected topic, normalized by the all worldwide
coverage monitored by GDELT and (ii) the average emotional
“tone” (i.e. sentiment) of the news detected. In the latter case,
an extreme negative (positive) score is assigned to each news
in accordance to the negative (positive) of the tone of each article.2
The results are averaged for the total daily news analyzed. Then,
it can be possible to propose an average net daily sentiment
(SE), considering both an unweighted metric (i.e. the index as
it is) and a weighted measure based of the media incidence of
cryptocurrency in a given day. In this case, the Normalized Media
Incidence is proposed as a measure of the article containing
the queried word, normalized for all the articles scraped by
the software. In this way, it will be possible not only to consider
the net positive/negative outcome of the lexicon-analysis, but also
the media relevance of this tone in a specific day. This can be
easily done by multiplying the average net daily sentiment by the
normalized daily media coverage of the topic. A quick overview
of both average returns and ICT data is included can be found
in Table 1. It can be observed that both average returns and
the average net daily sentiment exhibit a negative average value
during the period analyzed.

The methodology proposed is based on the econometric ap-
proach firstly adopted in Christie and Huang (1995) and Chang
and Zheng (2010) to detect financial herding. Such methodology
has been employed both in traditional assets market (see, for
instance, Gleason et al., 2004), both in cryptocurrencies market
(Vidal-Tomáš et al., 2019) to investigate this phenomenon. Firstly
we introduce the methodology of Christie and Huang (1995). Here,
returns dispersion is computed as the cross-sectional standard
deviation (CSAD):

\[
\text{CSAD}_{m,t} = \sqrt{\frac{\sum_{i=1}^{N} (r_{i,t} - \bar{r}_{m,t})^2}{N - 1}}
\]  \hspace{1cm} (2)

In this case, herding is detected in the market if there is a low
value of dispersion during periods of extreme market movements.
Christie and Huang (1995) investigate this effect considering the
lower and upper tail of the distribution of market returns:

\[
\text{CSAD}_{m,t} = \alpha + \beta^U D^U_t + \beta^L D^L_t + \varepsilon_t
\]  \hspace{1cm} (3)

where \(D^U_t\) and \(D^L_t\) are dummies equal to 1 if market return on
day \(t\) lies in the extreme upper tail and extreme lower tail (set
at 5% in this case) respectively. In this case herding is observed
for negative value of \(\beta^U\) and \(\beta^L\) coefficients, since the negative
relation identifies a convergence of behavior in correspondence
of extreme market movements. We extend this model by including
the Average Daily Sentiment (SE\(_{w}\)) derived from media coverage.

As discussed in the data section, two versions of such variable are
proposed, both unweighted (\(w = 0\)) and weighted (\(w = 1\)) for
the percentage of media coverage in the specific day. Hence, the
final model will be:

\[
\text{CSAD}_{m,t} = \alpha + \beta^U D^U_t + \beta^L D^L_t + \beta^M \text{SE}_{w,t} + \varepsilon_t
\]  \hspace{1cm} (4)

On the other hand, Chang and Zheng (2010) analyze herding
through the cross-sectional absolute deviation of returns (CSAD)
as a measure of return dispersion:

\[
\text{CSAD}_{m,t} = \frac{\sum_{i=1}^{N} |r_{i,t} - \bar{r}_{m,t}|}{N}
\]  \hspace{1cm} (5)

1 As mentioned in different authoritative blog of finance. See for instance Pedro Febrero, 2018.

2 In this work, the details of the lexicon-based methodology are not discussed, since this has been already properly done by the GDELT Team.
coming ahead with the following baseline econometric model to control for the relation between variability and average level of returns:

\[ \text{CSAD}_{m,t} = \alpha + \beta_1 r_{m,t} + \beta_2 |r_{m,t}| + \beta_3 r_{m,t}^2 + \epsilon_t \]  

where \(|r_{m,t}|\) is the absolute term and \(r_{m,t}^2\) denotes the square of market returns. In this case, the extreme market movements are identified by the square of market returns, hence a negative value of \(\beta_3\) indicates herding, that is a reduction of returns dispersion. Here again, the model is extended by considering the average net daily sentiment as before:

\[ \text{CSAD}_{m,t} = \alpha + \beta_1 r_{m,t} + \beta_2 |r_{m,t}| + \beta_3 r_{m,t}^2 + \beta_4 \text{SE}_w + \epsilon_t \]  

With the two extensions proposed, we can detect the impact of news regardless of (i.e. controlling for) the level of returns.

3. Empirical results

Tables 2–3 report the results for both CSSD (Table 2) and CSAD (Table 3) specifications introduced in Section 2. Baseline results – and then the relation between average returns and dispersion – in line with those of Vidal-Tomás et al. (2019), while some interesting insights emerge from the extended specification of the models. By observing the relationship between returns dispersion and their average level, and following the notion of herding introduced in the previous section it is possible to conclude that no herding exists. This can be attained since in Table 2 both \(\beta^2\) and \(\beta^2\) are positive and statistically significant, contrary to the theoretical prediction. Additionally, in Table 3 it can be observed that \(\beta_3\) is not negative. However, both the CSSD and the CSAD approach confirm the existence of a negative relation between news tone and returns dispersion. In particular, such relation is less evident if one considers the unweighted average net tone, maybe it clearly emerges when the daily tone is weighted by the volume incidence of news.\(^3\) In fact, by looking at \(\beta^2\) coefficient in Table 2 it can be observed that the magnitude of the coefficient in the weighted version \((w=1)\) is higher with respect to the unweighted one \((w=0)\). Similarly, in Table 3 the related coefficient \((\beta_4)\) has a higher value for \(w=1\). In all the cases the sign is negative, suggesting a reduction of dispersion associated with more optimistic news.

Results confirm that optimistic news are related to lower returns dispersion, highlighting a convergence of price expectation. As intuited in Philippas et al. (2019), media attention can be an important informative signal for the convergence of price expectations. Here, a clear empirical evidence of such relation has been provided. On the one hand, by looking at the relation between the level of returns and their dispersion, there is no evidence of herding. This result is perfectly in line with the baseline model of Vidal-Tomás et al. (2019). On the other hand, two major issues can be found when the effect of media is introduced.

Firstly, it can be observed that more optimistic (or less pessimistic) signals deriving from press news are associated with a reduction of returns dispersion (i.e. a convergence of beliefs). Additionally, such effect is amplified weighting for days when cryptocurrencies are most discussed. Indeed, an increase of the magnitude of the coefficient is observed when the average daily tone is weighed for the media relevance of bitcoin news of a specific day. Results found contribute to the identification of the key factors driving the price dynamics of cryptocurrency. As stated in Gurdgiev and O’Loughlin (2020), investors’ sentiments have an important link with price formation and beliefs, since optimism leads to rising prices and convergence of expectations. As suggested by the same authors, a natural extension of their study is the investigation of the study of the tone used by press and their incidence might be crucial in defining investors’ humor. To this extent, the current work covers this gap, showing how general media humor shapes markets’ beliefs. This can be directly observable by considering the reduction of returns dispersion associated with the optimism spread by worldwide media coverage.

4. Conclusion

The current work investigates the relation between sentiments deriving from daily worldwide online news and returns dispersion, contributing to the existing literature on financial market and herding behavior in cryptocurrencies market. Drawing on Christie and Huang (1995) and Chiang and Zheng (2010), both Cross Sectional Standard Deviation (CSSD) and Cross Sectional Absolute Deviation (CSAD) of 13 cryptocurrencies returns

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\[ \text{Table 1} \]

| Variable                  | Mean  | Standard deviation | Minimum | Maximum |
|---------------------------|-------|--------------------|---------|---------|
| Average returns           | -0.0028 | 0.0431              | -0.247  | 0.136   |
| Average net daily sentiment | -0.4184 | 0.597              | -3.142  | 2.387   |
| Normalized media incidence | 0.104  | 0.041              | 0.030   | 0.400   |

\[ \text{Table 2} \]

Results from CSSD model specifications with robust standard errors. (***), (**) denotes that the coefficient is significant at the (1%), (5%), (10%) level. Baseline results refer to Eq. (3), while the other two models refer to Eq. (4).

| Model | \(\alpha\)  | \(\beta_1\)  | \(\beta_2\)  | \(\beta_3\)  | \(\beta_4\)  | \(R^2\)  |
|-------|-------------|-------------|-------------|-------------|-------------|---------|
| Baseline | 0.027 (0.001)***  | 0.0216 (0.002)**  | 0.032 (0.004)***  | 0.191  |
| \(w=0\) | 0.0263 (0.003)**  | 0.0209 (0.002)**  | 0.031 (0.004)***  | -0.002 (0.001)**  | 0.195  |
| \(w=1\) | 0.025 (0.000)***  | 0.012 (0.002)**  | 0.023 (0.004)***  | -0.034 (0.008)***  | 0.212  |

\[ \text{Table 3} \]

Results from CSAD model specifications with robust standard errors. (***) denotes that the coefficient is significant at the (1%), (5%), (10%) level. Baseline results refer to Eq. (6), while the other two models refer to Eq. (7).

| Model | \(\alpha\)  | \(\beta_1\)  | \(\beta_2\)  | \(\beta_3\)  | \(\beta_4\)  | \(R^2\)  |
|-------|-------------|-------------|-------------|-------------|-------------|---------|
| Baseline | 0.0129 (0.000)***  | 0.032 (0.015)**  | 0.235 (0.034)***  | 0.243 (0.277)  | 0.352  |
| \(w=0\) | 0.0127 (0.000)***  | 0.032 (0.015)**  | 0.233 (0.034)***  | 0.232 (0.278)  | -0.001 (0.001)  | 0.353  |
| \(w=1\) | 0.0127 (0.000)***  | 0.031 (0.015)**  | 0.231 (0.034)***  | 0.167 (0.288)  | -0.017 (0.007)***  | 0.362  |

\(^3\) To validate the results found, additional attempts have been done considering SE as a dummy variable with value 1 in case of net positive sentiment and 0 vice versa. The related coefficient is \(-0.001 (p-value=0.06)\) and \(-0.001 (p-value=0.15)\) respectively for the CSAD and CSSD model.
have been employed to construct different model specifications. The time period have been selected in order to investigate the prevailing market dynamics after cryptos’ burst of 2017. Results evidence that, looking at the mean/variance returns relation, there are no evidence of herding. However, it can be observed a decrease of the dispersion during days where wave of optimism are spread by media.

The relationship between news optimism and convergence of price dynamics offers important insights for investors, since it remarks how the evaluation of cryptocurrencies is volatile and anchored to behavioral factors and investors’ humors. Therefore, this result offers interesting insights for future researches. For instance, it would be worthy to deeply discuss the causal linkage among news and price formation. To clarify, some limitations can be found in establishing the causal relationship, since it is not possible to establish the intra-day sequential order at which price changes and news are introduced. Hence, some future extensions might consider such aspects.

CRediT authorship contribution statement

**Rocco Caferra:** Conception and design, Acquisition of data, Analysis and interpretation of data, Writing - original draft, Writing - review & editing.

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References

Al-Khazali, O., Elie, B., Roubaud, D., et al., 2018. The impact of positive and negative macroeconomic news surprises: Gold versus bitcoin. Econ. Bull. 38 (1), 373–382.

Ballis, A., Drakos, K., 2020. Testing for herding in the cryptocurrency market. Finance Res. Lett. 33, 101210.

Bouri, E., Ckilias, K., Gupta, R., 2019a. Trade uncertainties and the hedging abilities of bitcoin. Econ. Notes e12173.

Bouri, E., Gupta, R., Roubaud, D., 2019b. Herding behaviour in cryptocurrencies. Finance Res. Lett. 29, 216–221.

Cheah, E-T., Fry, J., 2015. Speculative bubbles in bitcoin markets? An empirical investigation into the fundamental value of bitcoin. Econom. Lett. 130, 32–36.

Chiang, T.C., Zheng, D., 2010. An empirical analysis of herd behavior in global stock markets. J. Bank. Financ. 34 (8), 1911–1921.

Christie, W.G., Huang, R.D., 1995. Following the pied piper: Do individual returns herd around the market?. Financ. Anal. J. 51 (4), 31–37.

David Gerard, 2018. Bitcoin is less about technology than psychology. Interview released on the 02-Feb-2018, https://davidgerard.co.uk/blockchain/2018/02/02/bitcoin-is-less-about-technology-than-psychology.

Feng, W., Wang, Y., Zhang, Z., 2018. Informed trading in the bitcoin market. Finance Res. Lett. 26, 63–70.

Furnham, A., Boo, H.C., 2011. A literature review of the anchoring effect. J. Socio-econ. 40 (1), 35–42.

GDelt Project, 2020. GDELT: The global database of events, language, and tone. Online Access on August 2020, https://www.gdeltproject.org/about.html.

Gleason, K.C., Mathur, I., Peterson, M.A., 2004. Analysis of intraday herding behavior among the sector ETFs. J. Empir. Finance 11 (5), 681–694.

Song, Q., Almahdi, S., Yang, S.Y., 2017. Entropy based measure sentiment analysis in the financial market. In: 2017 IEEE Symposium Series on Computational Intelligence (SSCI). IEEE, pp. 1–5.

Vidal-Tomás, D., Ibáñez, A.M., 2018. Semi-strong efficiency of bitcoin. Finance Res. Lett. 27, 259–265.

Vidal-Tomáš, D., Ibañez, A.M., Farinós, J.E., 2019. Herding in the cryptocurrency market: CSSD and CSAD approaches. Finance Res. Lett. 30, 181–186.