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The Effects of Central Bank Digital Currency Communication and Associated Social Media Sentiment on Cryptocurrency Markets

Iulia Cioroianu^a, Shaen Corbet^{b,c}, Charles Larkin^{a,d*}, Les Oxley^c

^a*Institute for Policy Research, University of Bath, UK*

^b*DCU Business School, Dublin City University, Dublin 9, Ireland*

^c*School of Accounting, Finance and Economics, University of Waikato, New Zealand*

^d*Krieger School of Arts Sciences, Johns Hopkins University, Baltimore, MD, USA*

**Corresponding Author: imc40@bath.ac.uk*

Abstract

The creation of central bank digital currency (CBDC) has been seen as a potential mechanism for addressing some of the negative consequences of increased cryptocurrency popularity. It has also been linked to the introduction or strengthening of regulations related to digital money, with some central banks identifying the need for a comprehensive regulatory framework as a precondition for successful CBDC implementation. However, this type of central bank intervention can be seen by market participants as a threat to both confidentiality and potential cryptocurrency profitability. Linking computationally analysed social media data with hand-coded data from the websites of major central banks, we test the effects of CBDC-related announcements and social media sentiment on 210 blockchain and cryptocurrency fund products. We find that for a large majority of these products, central bank announcements elicit significant returns and volatility responses, with some variation in response related to geographical region. Both central bank announcements and positive social media CBDC-related sentiment are associated with reduced cryptocurrency exchange traded fund (ETF) returns and increased volatility. Our results provide evidence of a largely negative market response to the threat of potential cryptocurrency regulation that can be directly linked to CBDC development.

Keywords: Cryptocurrency; CBDC; Social Media; Sentiment; Central Bank; Exchange Traded Funds.

1. Introduction

Anonymity in the process of financial transactions, and the ability to invest assets without verification, have been observed as key features that continues to attract cryptocurrency enthusiasts [Foley et al., 2019]. The ability of ‘investors’ to open cryptocurrency investment accounts in jurisdictions with weak, and in some cases, non-existent KYC (Know-Your-Customer) regulations, has been a source of concern for regulatory authorities, many of whom have been attempting to shore up regulatory conditions [Fletcher et al., 2021].

The intention and realised development of Central Bank Digital Currencies (CBDC hereafter), has been observed as one of the key disrupting forces, against largely unchallenged cryptocurrency growth and development, which has so far resulted in a host of altcoins that have been exposed to the forces of social media-driven price manipulation, while being largely compromised by broad illegality through a number of both simplistic and complicated channels alike [Griffin and Shams, 2020, Corbet et al., 2020, Cioroianu et al., 2021a]. Over the past four years multilateral agencies such as the World Bank, IMF and Bank for International Settlements have worked with several central banks to develop a steadily more sophisticated understanding of the design, implementation, operation and regulation of a CBDC in the context of Decentralised Finance (DeFi) and cryptocurrencies [Mancini-Griffoli et al., 2018, Adrian and Mancini-Griffoli, 2019, Alvarez and Argente, 2020]. As recently as January 2022 the Bank for International Settlements has placed CBDCs, next generation payments systems and DeFi, and the development of new technological public goods for central banks at the core of their Innovation Hub work programme, coordinating the efforts of several national central banks¹. Importantly, the US Federal Reserve has begun the process of consultation on a CBDC as of January 2022, with a significant Board of Governors consultation paper².

CBDCs, representing a version of central bank supported digital assets, present an avenue through which many channels of illicit behaviour can be removed, while further issues relating to moral hazard and asymmetric information can be largely mitigated, significantly reducing the presence of non-transparent transactions [Corbet and Cumming, 2020, Agur et al., 2022]. Despite the fact that the development of CBDCs does not necessarily imply increased regulation of cryptocurrency markets (and can in fact be seen as a direct and efficient alternative to regulatory provisions and legal enforcement [Usher et al., 2021]), some central banks have either identified the need for tighter regulation of digital money as a precondition for the successful implementation of CBDCs, or have taken marked regulatory steps which coincided with CBDC pilot releases. The recent Bank

¹Further information is available at the following [link](#).

²Money and Payments: The U.S. Dollar in the Age of Digital Transformation, Board of Governors of the Federal Reserve System, 2022. Available [here](#).

of England discussion paper on new forms of digital money [Bank of England, 2021], as well as a subsequent response paper note that "regulation lays the groundwork for innovation and needs to be clearly established before a systemic stablecoin could safely operate in the UK" [Bank of England, 2022]. As an extreme example of the link between CBDC development and digital currency regulation, the People's Bank of China outlawed the issuance of all private digital currencies before piloting its national digital currency in 2020. [Laboure et al., 2021]

It is therefore not surprising that market participants would formulate specific sets of expectations related to the effects of CBDC development on cryptocurrency markets, and associate CBDC announcements with potentially increased cryptocurrency regulation. As a consequence, we would expect such central bank announcements to generate significant effects in relation to cryptocurrency returns and volatility. Specifically, we expect the threat of regulation stemming from the announcements to be associated with reduced cryptocurrency returns and overall increases in volatility. At the same time, given the documented importance of social media in relation to cryptocurrency markets [Guégan and Renault, 2021, Naeem et al., 2021, Kraaijeveld and De Smedt, 2020], we also expect the relation between central bank announcements and cryptocurrency outcomes to be partially mediated by social media sentiment.

Using a large number of blockchain and cryptocurrency-related exchange traded fund (ETF hereafter) products, this paper investigates the specific effects of social media coverage relating to CBDCs - as measured by the polarity and overall subjectivity of discussion over time - along with the release dates of CBDC-based research - as circulated by six of the largest international central banks - to specifically investigate whether cryptocurrency markets are affected by CBDC announcements and the sentiment surrounding them. Specifically, we test the scale and direction of market response in terms of both returns and volatility, observed not only to be representative of the intensity of market reaction, but also the disruption and disorientation generated therein.

2. Data

We collected cryptocurrency funds data from Thomson Reuters Eikon for the period 1 January 2017 through 30 September 2021. In total, 210 funds were identified to have been based on either blockchain or cryptocurrency investment³. The funds are further separated by type and geographic region. Returns by product-type are presented in Figure 1, and respective summary statistics are presented in Table 1. We define returns as the daily log changes and volatility as the five-day standard deviation - an approach which has been detailed in Corbet et al. [2018] and Cioroianu

³An additional 189 funds were not included in this analysis as they did not possess data in excess of one year of duration, or did not present daily transactions throughout the entire period of analysis.

et al. [2021b].

Insert Table 1 and Figure 1 about here

We next obtained data on social media sentiment from Twitter, which is considered one of the main platforms for cryptocurrency related discussion. [Tandon et al., 2021] All tweets mentioning the terms “CBDC”, “#CBDC” and “central AND bank AND digital AND currency” were computationally collected through the Twitter v2 API (the academic access track) using the R package ‘academictwitter’ Barrie and C.T.Ho [2021]. A total number of 761,704 unique tweets were collected between the beginning of 2017 and the end of 2021. ⁴. The data was then aggregated by date as presented in Figure 2, with further summary statistics presented in Table 2, taking sums of the quantitative variables and aggregating the text.

Insert Table 2 and Figure 2 about here

We computationally derive the sentiment expressed in the Twitter data using the Harvard General Inquirer IV-4 lexicon [Stone et al., 1966] and the Loughran and McDonald Financial Sentiment lexicon [Loughran and McDonald, 2011]. The former is a popular general-purpose lexicon developed by psychologists, which has been used extensively to evaluate a range of emotions in written texts, and the latter is a domain-specific lexicon designed for the study of sentiment in finance corpora. The lexicons were applied to the collected tweets using the Python package ‘pysentiment’. The following measures were computed: 1) counts of positive terms; 2) counts of negative terms; 3) a measure of polarity calculated as the number of positive terms minus the number of negative terms divided by the sum of positive and negative terms; and 4) a measure of subjectivity (affect) calculated as the proportion of negative and positive terms relative to the total number of terms in the text. The measures were applied on the daily-aggregated text of the tweets.⁵ Figure 3 presents the evolution of the positive and negative emotion measures over time. As a defining feature, the Loughran and McDonald lexicon captures more negative emotion terms, mainly through the inclusion of domain-specific words, while the Harvard General Inquirer captures more general language terms associated with positive emotion [Loughran and McDonald, 2011]. In subsequent analyses we therefore focus on the relative proportions of positive and negative terms (the polarity measure),

⁴For brevity, additional summary statistics based on these tweets are available from the authors upon request.

⁵Unlike other computational text analysis methods which can be used to evaluate tonality, such as unsupervised learning, lexicon analysis is not sensitive to the volume of text, or the aggregation interval used. Our results would therefore be identical if the lexicons were applied at the tweet level, instead of the aggregated text of all tweets over the length of a day. Applying the lexicon following aggregation is however more computationally efficient.

which provides a more accurate and sensitive measure of sentiment, allowing us to capture its fluctuations. We also include the computed measures of overall affect (or subjectivity), and report results based on both lexicons.

Insert Figures 3 and 4 about here

For our final source of data, we studied the websites of the U.S. Federal Reserve, the European Central Bank, the Bank of England, the Bank of Japan, the Swiss National Bank, and the Bank of Canada, and manually coded the dates of all releases relating explicitly to either CBDC or central bank-denoted cryptocurrencies. Figure 4 presents the time series relating to these announcements.

Our final data processing step involved linking the Thomson Reuters Eikon funds data, social media sentiment polarity and affect measures, and the central bank announcements series at the day level.

3. Empirical Approach and Results

We specifically investigate the potential effects stemming from the growing focus of major international central banks on CBDC and broad cryptocurrency regulation upon funds with a focus on digital technology. Any identified behavioural responses would be considered to be connected with future expectations with regards to third-party regulatory involvement in these developing financial assets. To specifically account for such effects, we employ a GARCH (1,1) methodology as developed by Bollerslev [1986] and previously used in a similar manner by Corbet et al. [2020, 2021], of the following form:

$$R_t = a_0 + \sum_{j=1}^5 b_j R_{t-j} + b_2 DJ_t + b_3 S_t + D_{reg} + \varepsilon_t \quad (1)$$

$$\varepsilon_t | \Omega_t \sim i.i.d. \quad N(0, h_t) \quad (2)$$

$$h_t = \omega + \alpha_1 h_{t-1} + \beta_1 u_{t-1}^2 \quad (3)$$

R_{t-j} represents the lagged value of the selected cryptocurrency-based fund returns, j number of periods before R_t is observed. $b_2 DJ_t$ represents the effects of the Dow Jones Industrial Average as a measure of international effects. $b_3 S_t$ represents the effects of sentiment. We evaluate the effects of sentiment as measured through each of the two lexicons (Loughran and McDonald - LM; Harvard General Inquirer IV - HI), and both the polarity and subjectivity measures. D_{reg} captures

the effects of announcements made by major central banks which were explicitly related to either CBDC or central bank-denoted cryptocurrencies. Estimates with respect to volatility are obtained from an identical model, through the use of the same sentiment and regulatory variables. As per Corbet et al. [2020], we present Bonferroni-adjusted results in this analysis⁶. This methodological structure enables robust analysis with regards to the concomitant influence of both sentiment and central banking announcements relating to CBDC.

Insert Tables 3 and Figure 5 about here

Table 3 presents the proportion of coefficients that were significant at the 1% level for each GARCH(1,1) model described above. Separate models were fitted for returns and volatility, and within each of them results are presented for each lexicon (LM and HI), and for both the polarity and subjectivity measures. The results are further separated by fund type and geographical region.

Focusing initially on key differentials as identified by type of fund, and then by geographic region, a number of interesting observations can be made. In over half of all analysed funds, as separated by type, there exists a significant response to both returns and volatility at the 1% level in the aftermath of central bank announcements relating to CBDC. The largest influential pathways from sentiment are identified for returns relating to other types of exchange-traded products, however, substantial volatility interactions are identified throughout.

From a geographic perspective, it is quickly apparent that there exist significant regional differentials of response, particularly in the United States, where very low numbers of significant estimates are observed for both sentiment and regulatory mentions, both in the case of returns and volatility of the analysed exchange traded fund products. Such a result is most likely a side-effect of the perceived weakness of any potential regulatory intervention due a lack of concise signalling, but also possibly due to recent messaging board stock attacks and a perceived inability to robustly clampdown on much of the fraud that has been inherent within cryptocurrencies and their associated by-products for the best part of a decade.

Figure 5 shows the values of the polarity and central bank announcement coefficients which are significant at the 1% level in the GARCH(1,1) model, for returns (i) and volatility (ii). The majority of estimates for polarity, as well as central bank announcements in the returns model are negative, with stronger observed average effects for central bank announcements. On the other hand, both sentiment and central bank announcements relating to CBDC are found to significantly increase the volatility of analysed ETF-products, accounting for average elevations of 6.95% and

⁶To cater to the multiple hypothesis problem, we adjust the significance level using the Bonferroni correction, which leads to a significance level of 0.1%.

6.26% respectively.

4. Conclusions

This research presents significant evidence of a further layer of fragility that has been influencing cryptocurrency markets, specifically the threat of third-party, central bank-driven market entry and intervention. Results indicate that sentiment effects relating to social media discussions surrounding CBDC significantly reduce cryptocurrency-related ETF returns, while simultaneously increasing respective short-term price volatility. The influence of central bank announcements relating to CBDC is found to be even more pronounced. These results support the view that the threat of future regulation, or third-party oversight, appears to generate significant concern among cryptocurrency investors. Anonymity and the freedom to move outside of the scope of regulatory observation represent some of the strongest attractions with regards to some digital assets. As new CBDCs seek to supplant stablecoins and traditional cryptocurrencies, and regulators seek to replicate much of the traditional transaction tracking from the existing national and transnational banking system, central bank coordination and announcements in this space are perceived by market participants as a signal that the use of cryptocurrencies for non-transparent transactions will become more difficult. The removal of, or third-party intervention to this freedom and programmed anonymity, is found to present a threat to future viability of existing cryptocurrencies. CBDCs, in the eyes of cryptocurrency investors, appear to act like streetlights and sunlight, a most effective policeman and disinfectant.

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Table 1: Summary statistics relating to selected cryptocurrency-related funds

<i>Fund Type</i>	Mean	Variance	Skewness	Kurtosis	Minimum	Maximum
Equity ETF	0.0040	0.0011	1.7306	25.1412	-0.2227	0.3178
Exchange-Traded Fund	0.0005	0.0016	-1.7714	8.1630	-0.2608	0.1173
Exchange-Traded Note	0.0045	0.0024	0.0120	13.8792	-0.3572	0.3983
Other Exchange-Traded Product	0.0039	0.0016	-0.6596	7.5798	-0.2675	0.2026
Open-End Fund	0.0037	0.0027	-0.0715	12.3390	-0.3262	0.3573
<i>Geographic Region</i>	Mean	Variance	Skewness	Kurtosis	Minimum	Maximum
Australia	0.0023	0.0037	-1.3619	9.9994	-0.3679	0.2786
Brazil	0.0033	0.0028	3.2498	27.7896	-0.1369	0.4344
Canada	0.0007	0.0023	1.1965	10.3929	-0.1401	0.3098
Germany	0.0036	0.0020	-0.8217	6.7561	-0.2942	0.2348
Netherlands	0.0024	0.0020	0.0131	1.7053	-0.1416	0.1561
Switzerland	0.0035	0.0018	-0.4419	14.8155	-0.3362	0.2877
United Kingdom	0.0103	0.0044	3.9241	24.1095	-0.1154	0.4815
United States	0.0039	0.0011	2.8285	37.3573	-0.2225	0.3488

Note: The above data is based on the period 1 January 2017 through 30 September 2021. In total, 210 funds were identified to have been based on either blockchain or cryptocurrency investment.

Table 2: Summary statistics relating to collected social media data

Time Period	Tweets	Likes	Retweets
2017 Q1	3,320	29,673	1,498
2017 Q2	5,482	293,231	3,871
2017 Q3	3,370	104,234	2,818
2017 Q4	4,695	25,472	2,199
2017 Total	16,867	452,610	10,386
2018 Q1	4,535	275,587	5,209
2018 Q2	11,013	315,686	8,722
2018 Q3	6,838	230,185	5,343
2018 Q4	7,810	622,312	10,525
2018 Total	30,196	1,443,770	29,799
2019 Q1	5,486	67,361	6,682
2019 Q2	6,567	206,414	9,780
2019 Q3	17,142	4,133,913	29,133
2019 Q4	32,317	4,375,106	62,365
2019 Total	61,512	8,782,794	107,960
2020 Q1	37,220	1,563,719	70,784
2020 Q2	38,317	927,914	63,948
2020 Q3	54,713	1,959,856	104,673
2020 Q4	76,679	1,838,124	160,964
2020 Total	206,929	6,289,613	400,369
2021 Q1	95,912	6,464,895	259,307
2021 Q2	162,536	31,404,284	451,578
2021 Q3	187,752	40,402,754	503,500
2021 Total	446,200	78,271,933	1,214,385
Total Period	761,704	95,240,720	1,762,899

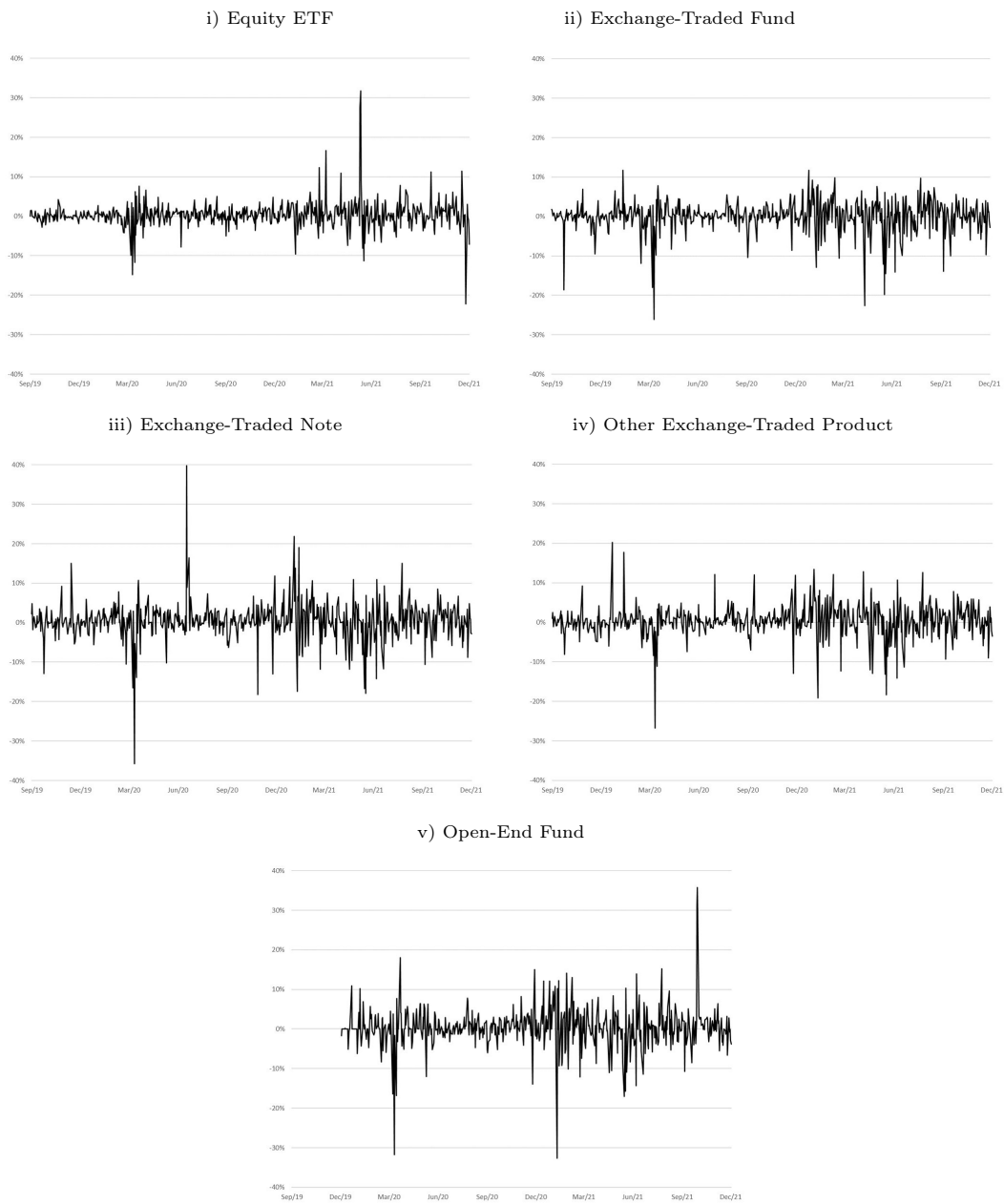
Note: All tweets mentioning the terms “CBDC”, “#CBDC” and “central AND bank AND digital AND currency” were computationally collected. A total number of 761,704 unique tweets were collected between Q1 2017 and Q3 2021.

Table 3: Proportion of significant coefficients in returns and volatility models

<i>Fund Type</i>	<i>Returns</i>						<i>Volatility</i>					
	LM Pol.	HI Pol.	Reg.	LM Subj.	HI Subj.	Reg.	LM Pol.	HI Pol.	Reg.	LM Subj.	HI Subj.	Reg.
Equity ETF	40.4%	41.2%	46.7%	48.1%	44.6%	56.9%	49.0%	53.1%	54.2%	55.2%	57.3%	52.1%
Exchange-Traded Fund	16.7%	33.3%	33.3%	66.7%	16.7%	66.7%	33.3%	16.7%	50.0%	50.0%	50.0%	83.3%
Exchange-Traded Note	34.3%	41.1%	46.0%	34.9%	47.6%	60.3%	34.9%	47.6%	60.3%	31.7%	68.3%	54.0%
Other Exch-Traded Products	61.9%	76.2%	61.9%	78.6%	59.5%	85.7%	78.6%	59.5%	85.7%	59.5%	73.8%	66.7%
<i>Geographic Region</i>	LM Pol.	HI Pol.	Reg.	LM Subj.	HI Subj.	Reg.	LM Pol.	HI Pol.	Reg.	LM Subj.	HI Subj.	Reg.
Germany	42.6%	50.0%	63.2%	51.5%	58.8%	77.9%	51.5%	58.8%	77.9%	70.6%	83.8%	72.1%
Switzerland	81.0%	71.4%	95.2%	95.2%	71.4%	71.4%	95.2%	71.4%	71.4%	61.9%	81.0%	76.2%
United States	5.6%	7.2%	7.8%	7.8%	7.2%	13.9%	7.8%	7.2%	13.9%	15.6%	14.4%	17.8%
Other	56.5%	53.2%	65.8%	66.5%	64.5%	77.4%	65.0%	64.5%	59.0%	54.8%	58.2%	87.1%

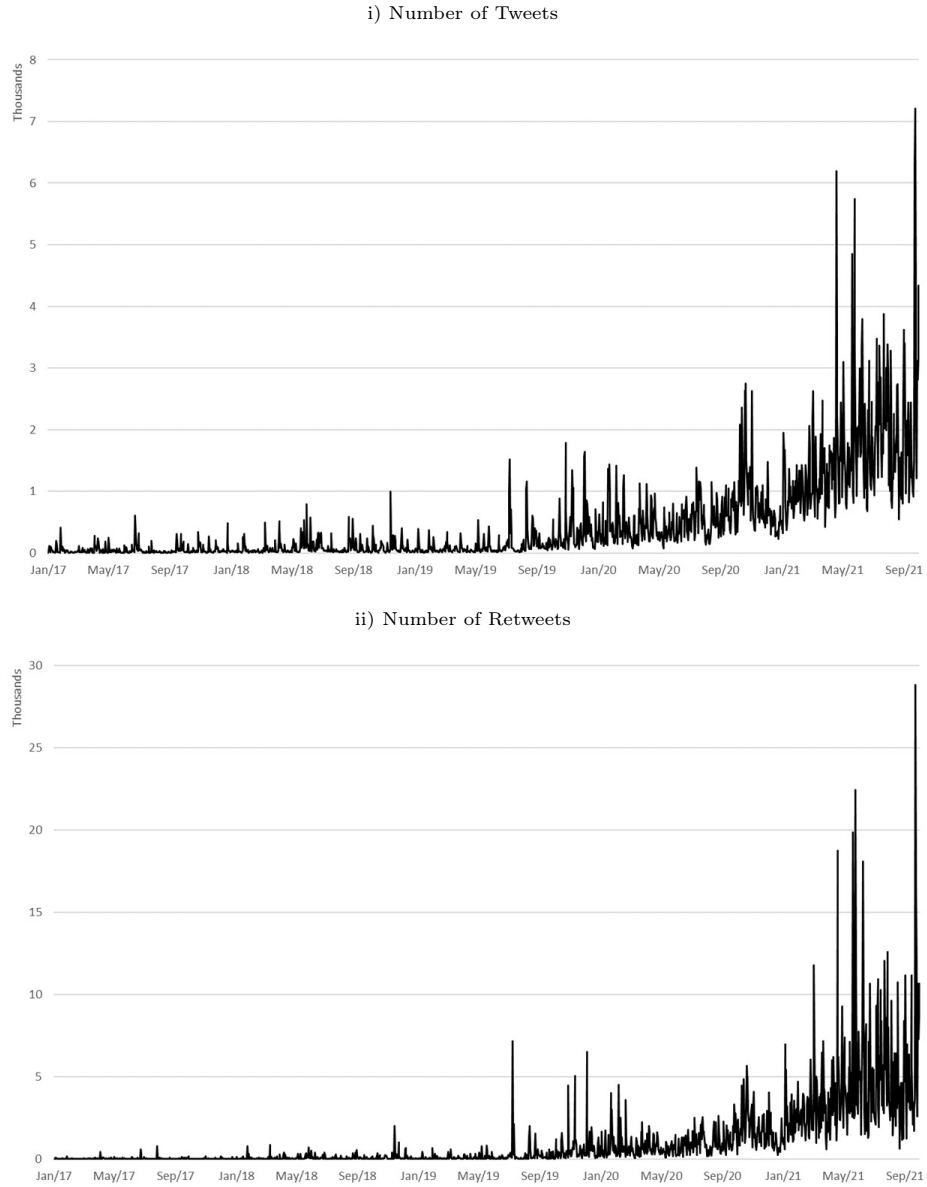
Note: The above results present the proportion of coefficients for sentiment (polarity and subjectivity) and central bank announcements that were significant at the 1% level in each GARCH(1,1) model. For brevity, individual methodological results, and those results focusing on variants of the presented dummy variables as a robustness testing mechanism have been omitted, but are available from the authors upon request.

Figure 1: Asset performance as separated by fund type



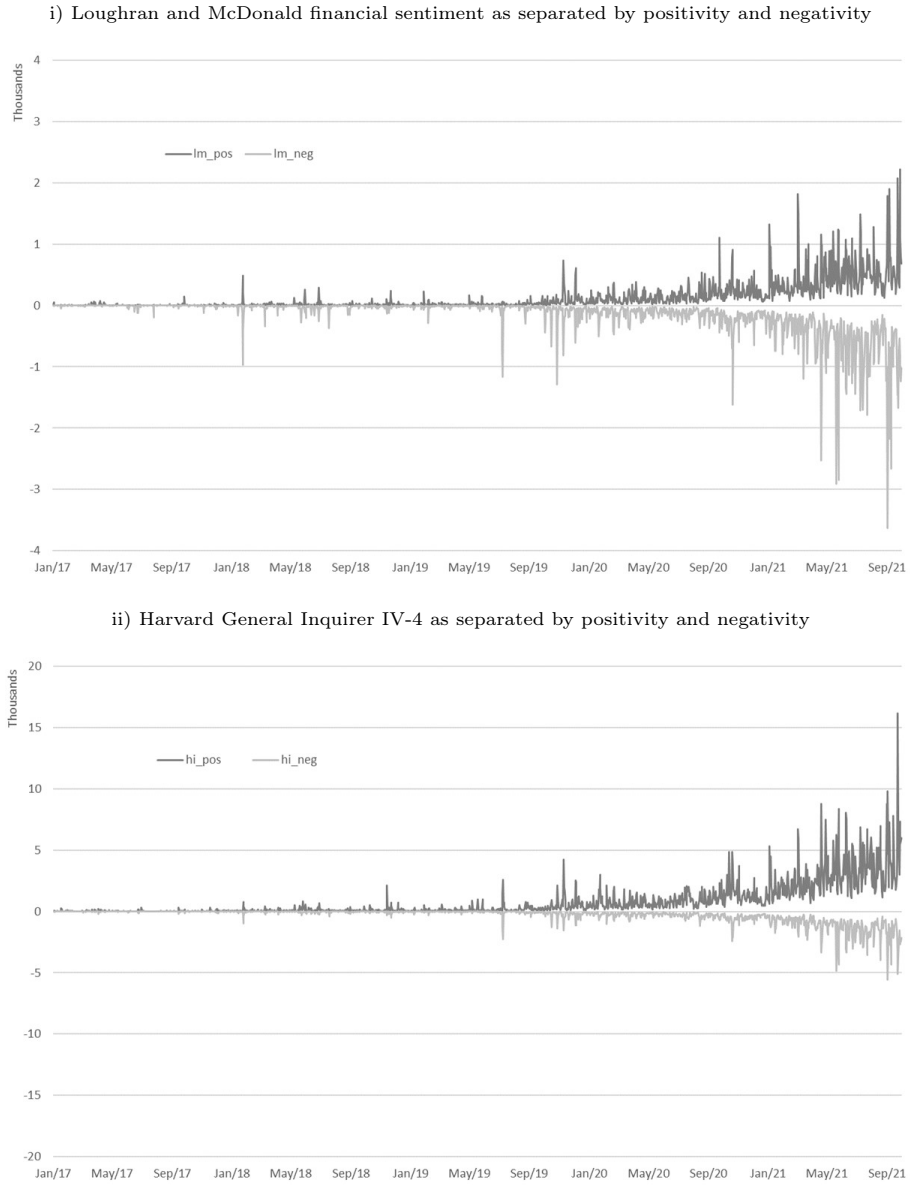
Note: The above data is based on the period 1 January 2017 through 30 September 2021. In total, 210 funds were identified to have been based on either blockchain or cryptocurrency investment.

Figure 2: Social media data relating to CBDC



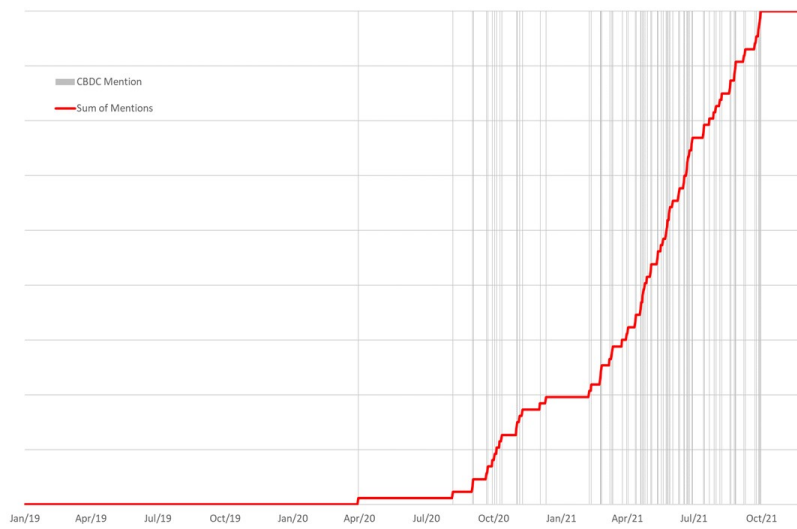
Note: All tweets mentioning the terms “CBDC”, “#CBDC” and “central AND bank AND digital AND currency” were computationally collected. A total number of 761,704 unique tweets were collected between Q1 2017 and Q3 2021.

Figure 3: Sentiment in tweets mentioning CBDC



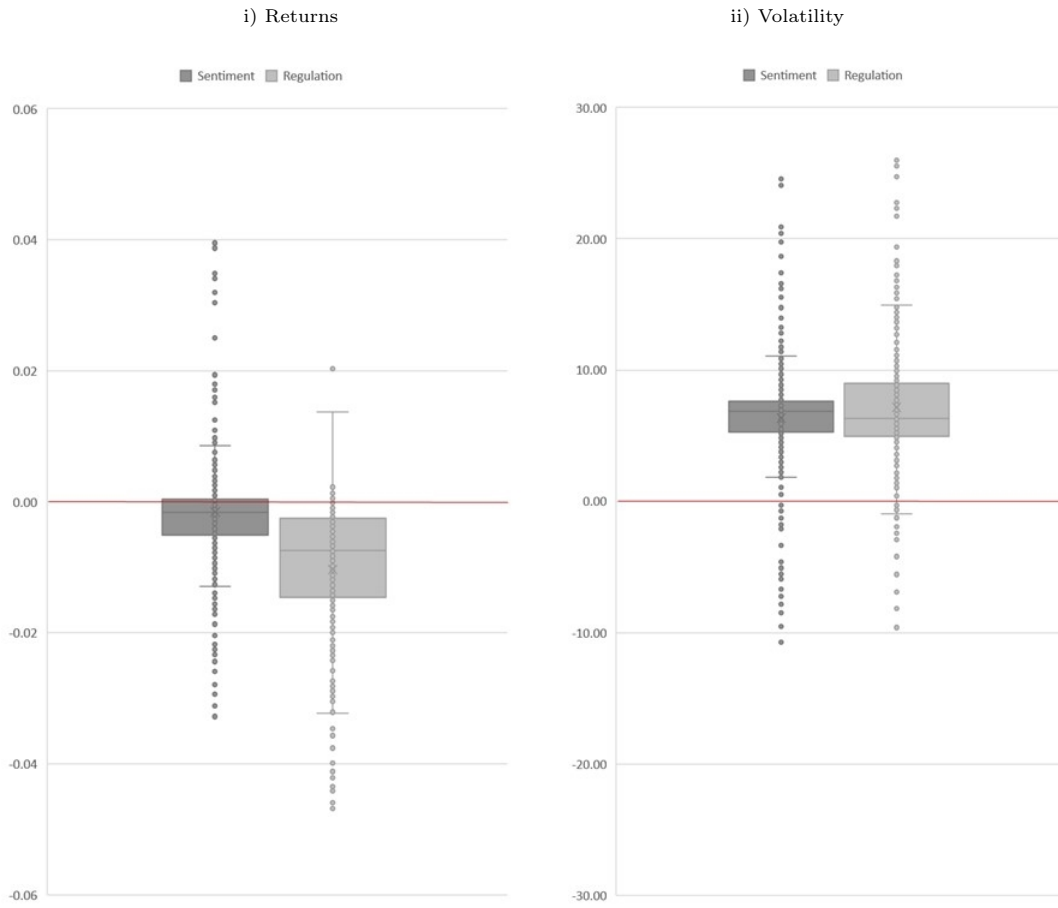
Note: The sentiment variables are based on the Loughran and McDonald Financial Sentiment lexicon and the Harvard General Inquirer IV-4 lexicon.

Figure 4: Major central bank mentions with regards to CBDC (2019-2021)



Note: In the above figure, we present the time series of all announcements made on the websites of the U.S. Federal Reserve, the European Central Bank, the Bank of England, the Bank of Japan, the Swiss National Bank, and the Bank of Canada and which were related explicitly to either CBDC or central bank-denoted cryptocurrencies.

Figure 5: Return and volatility differentials based on sentiment and regulatory effects



Note: Individual GARCH(1,1) coefficients for polarity and central bank announcements in the returns (i) and volatility (ii) models.