Time-Varying Causality Between Bitcoin and Attention to COVID-19 News: Cultural Grouping

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Abstract

The pandemic and people’s concern over it are associated with the Bitcoin market, while the extent of individualism differentiates how individuals regard and react to the viral spread and corresponding measures. This paper examines if real-time attention to country-specific COVID-19 news Granger causes daily Bitcoin returns and trading volumes between February 13, 2020 and April 04, 2022, and whether the causal relationship varies time-wise between the collectivistic and individualistic country group. Results show different timing and spans of the causality. In general, attention to COVID-19 news of the individualistic cluster presents stronger evidence of causal effects on both Bitcoin returns and trading volumes.

JEL Classification: G41; G12; G15
Keywords: Bitcoin; COVID-19; individualism; Google Search Volume Index; attention; news

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1 Introduction

Since the first known outbreak of COVID-19, Bitcoin price increased by more than 700% at its peak. A co-movement was identified between the exploding price and worldwide daily deaths caused by COVID-19 (Goodell and Goue 2021). Sarkodie et al. (2022) showed that a 1% increase in COVID-19 confirmed cases and deaths raised Bitcoin price by 1.34% and 1.62%. Zhang et al. (2022) also revealed a significant interaction among COVID-19 related news and the Bitcoin market within a week. Further, fear sentiment towards COVID-19 was found associated with low returns today but high returns tomorrow and spurred the trading volume and volatility (Chen et al. 2020; Da et al. 2015). While the negative effects of a fear shock on Bitcoin returns were more persistent after the pandemic than before (Polat et al. 2022). Despite different approaches, it is evident that the evolution of COVID-19 and the exposure to its news influence the Bitcoin market.

At the same time, recent studies suggest that cultural characteristics play a critical role in preventive behaviors and health outcomes. More individualistic countries reported more cases and/or higher fatalities during the pandemic (e.g., Maaravi et al. 2021; Ozkan et al. 2021). Chen et al. (2021) examined the role of cross-cultural differences in people’s reactions to preventive policies among 111 countries, showing that countries, where individualism prevailed, saw less compliance with stay-at-home orders. In addition, Bazzi et al. (2021) and Bian et al. (2022) demonstrated that more individualistic US counties were more reluctant to a variety of socially optimal actions, such as social distancing, mask use, or receiving vaccine. Particularly, even with the individual-level data, the extent of individualism was found to have a significant and robust negative effect on responses to stay-at-home orders (Bian et al. 2022).

The pandemic situation and people’s concern over it are associated with the Bitcoin market, while individualism and collectivism, as an element of culture, differentiate how individuals regard and react to the viral spread and corresponding measures. A question consequentially appears: do collectivistic and individualistic countries differ in influencing the Bitcoin market?

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1Chen et al. (2020) found a negative effect of fear on Bitcoin returns at lag 3 but a positive effect at lag 4, showing return reversals as discussed in Da et al. (2015).
This paper attempts to answer this question by focusing on the intensity of real-time attention to COVID-19 news of collectivistic and individualistic countries, retrieved from Google Trends, and investigating the evolving causal relationship between the attention and daily Bitcoin returns and trading volumes. Greater attention to COVID-19 news implies more exposure to it. To this end, two newly-developed time-varying Granger causality tests are adopted (Shi et al. 2020; 2018). This paper is close to Caporale and Kang’s (2020) study where a one standard deviation increase in individualism was found correlated with a 3.3% decrease in Bitcoin price co-movements; to Chen et al.’s (2022) finding that individualistic culture weakened the willingness to buy Bitcoin during the lockdown; to Fernandez-Perez et al.’s (2021) central idea that national culture has an impact on how investors perceive and respond to the pandemic.

Additionally, this study relates to another three strands of literature. Firstly, a growing body of literature uses time-varying Granger causality tests (e.g., Diniz et al. 2022; Hu et al. 2020). Secondly, financial studies focus on the role of individualism (e.g., Salcedo and Gupta 2021; Todea and Buglea 2017). Lastly, Bitcoin research relies on Google Trends data (e.g., Urquhart 2018; Zhang et al. 2021).

2 Data and Methodology

2.1 Data Source

Daily data of Bitcoin prices and trading volumes between February 13, 2020 and April 04, 2022 are retrieved from Bitcoincharts.\(^2\) Bitcoin return is defined as \(r_t = \ln \left( \frac{P_t}{P_{t-1}} \right)\). The intensity of daily attention to country-specific COVID-19 news is measured through worldwide Google Search Volume Index (GSVI) under the category of news search, using “COVID” plus the official and abbreviation names of a country as keywords.\(^3\) As the GSVI is normalized data, reflecting the real-time interest in a country’s COVID-19 news relative to all topic searches on Google,

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\(^{2}\)February 13, 2020 is the earliest date that a combined term including “COVID” can be tracked through Google Trends because the World Health Organization released the official name “COVID-19” on February 11, 2020.

\(^{3}\)For example, I entered “COVID UK+Britain” to collect the relevant GSVI of the UK. Using “COVID” obtains more inclusive results than using “COVID-19” because users don’t necessarily add “-19” to search terms. Please see search tips here.
its feature allows me to compare the magnitude of attention across both dates and countries, regardless of the population of users.

Table 1: Interest By Region (News Search)

| Top-3 Regions | Individualism | Collectivism |
|---------------|---------------|--------------|
| **USA:**      | 1. Canada (100), 2. New Zealand (89), 3. USA (85) | 1. Brunei (100), 2. Singapore (92), 3. Cambodia (55) |
| **UK:**       | 1. UK (100), 2. St. Helena (32), 3. Ireland (25) | 1. Mexico (100), 2. El Salvador (9), 3. Costa Rica (7) |
| **France:**   | 1. France (100), 2. Luxembourg (54), 3. Tunisia (29) | 1. Portugal (100), 2. Luxembourg (10), 3. Switzerland (4) |
| **Ireland:**  | 1. Ireland (100), 2. UK (2), 3. Lithuania (1) | 1. Colombia (100), 2. Aruba (55), 3. El Salvador (12) |
| **Sweden:**   | 1. Sweden (100), 2. Jersey (98), 3. Slovenia (30) | 1. China (100), 2. Singapore (82), 3. Malaysia (50) |
| **Australia:**| 1. Australia (100), 2. New Zealand (32), 3. Bahrain (22) | 1. Singapore (100), 2. South Korea (76), 3. Philippines (56) |

Notes: The scale of GSVI is 0 to 100.
Source: Google Trends (February 13, 2020 – April 04, 2022).

In terms of Hofstede et al.’s (2010) cultural dimensions, I selected the USA, the UK, France, Ireland, Sweden, and Australia from relatively individualistic countries and selected Japan, Mexico, Portugal, Colombia, China, and South Korea from relatively collectivistic countries as representative examples, because they present the largest GSVI relative to their tendency of individualism. The intensity of daily attention to COVID-19 news finally utilized is then the arithmetic mean of six GSVIs within each cluster. The average GSVI of the two clusters is 37.19 (individualism) and 32.70 (collectivism). Table 1 shows that regions that are most interested in a country’s COVID-19 news often belong to that country or, at least, to that cultural group. The linkage between the country to which users paid attention and users’ locations signifies that the likelihood for people to be influenced by a collectivistic or individualistic culture of the

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4The base culture data are quantified between 0 and 100. Here, countries with a score of individualism < 50 are considered as collectivism-oriented. In contrast, countries scored ≥ 50 are relatively individualistic.
They cared is very large.

2.2 Time-Varying Granger Causality Tests

Following Shi et al.’s (2018) procedure, an unrestricted VAR(p) model can be written as:

$$y_t = \phi_0 + \phi_i \sum_{i=1}^{p} y_{t-i} + \epsilon_t$$

where $y_t$ is a vector of variables of interest. $\phi_0$ is a vector of constants, and $\epsilon_t$ is a vector of independent white noise innovations.

The Wald test of the restrictions imposed by the null hypothesis has the general form:

$$W = [R vce(\hat{\Pi})]' [R(\hat{\Omega} \otimes (X'X)^{-1})R']^{-1} [R vce(\hat{\Pi})]$$

where $vce(\hat{\Pi})$ denotes the (row vectorized) $2(2p+1) \times 1$ coefficients of $\hat{\Pi}$, and $R$ is the $p \times 2(2p+1)$ selection matrix. Each row of $R$ picks one of the coefficients to set to zero under the non-causal null hypothesis.

Shi et al.’s (2018) proposes three tests based on the supremum norm (sup) of a series of recursively evolving Wald test statistics to detect real-time changes in causality using a forward recursive (Thoma 1994), a rolling window (Swanson 1998) and a recursive evolving algorithm (Phillips et al. 2015a; b). The origination (termination) date of a change in causality is identified as the first observation whose test statistic value exceeds (goes below) its corresponding critical value.

The Wald statistic obtained for each sub-sample regression, using observations over $[f_1, f_2]$ with a sample size fraction of $f_w = f_2 - f_1 \geq f_0$, is denoted by $W_{f_2}(f_1)$, and the supremum Wald statistic is defined as:

$$SW_f(f_0) = \sup_{(f_1, f_2) \in \Lambda_0, f_2 = f} \{W_{f_2}(f_1)\}$$

where $\Lambda_0 = \{(f_1, f_2) : 0 < f_0 + f_1 \leq f_2 \leq 1, \text{and} 0 \leq f_1 \leq 1 - f_0\}$ for some minimal sample size $f_0 \in (0, 1)$ in the regressions. This is the so-called recursive evolving procedure.

Let $f_e$ and $f_f$ denote the origination and termination points in the causal relationship that
are estimated as the first chronological observation whose test statistic exceeds or falls below the critical value. Because the power of the recursive evolving procedure is found to be best, and both the recursive evolving and rolling procedure perform much better than the forward recursive procedure (Shi et al. 2020; 2018), the analysis relies on dating rules of the following two algorithms:

\[
\text{Rolling} : \hat{f}_e = \inf_{f \in [f_0, 1]} \{ f : W_f(f - f_0) > cv \} \quad \text{and} \quad \hat{f}_f = \inf_{f \in [\hat{f}_e, 1]} \{ f : W_f(f - f_0) < cv \} \quad (4)
\]

\[
\text{Recursive Evolving} : \hat{f}_e = \inf_{f \in [f_0, 1]} \{ f : SW_f(f_0) > scv \} \quad \text{and} \quad \hat{f}_f = \inf_{f \in [\hat{f}_e, 1]} \{ f : SW_f(f_0) < scv \} \quad (5)
\]

where \( cv \) and \( scv \) are the corresponding critical values of the \( W_f \) and \( SW_f \) statistics. For multiple switches, the origination and termination dates are estimated in a similar fashion. All procedures are implemented under the null hypothesis of no causality and under the assumption of either homoskedasticity or conditional heteroskedasticity of an unknown form.

3 Empirical Results

To estimate the VAR model and implement Shi et al.’s (2018) tests, I used the Bayesian information criteria (BIC) with a maximum potential lag length 12 to select the lag order. The minimum window size \( f_0 \) is set to 0.2. The critical values are obtained from a bootstrapping procedure with 499 replications. The empirical size is 5% and is controlled over a three-month period. These settings are consistent with the empirical analyses shown in Shi et al. (2018). Further, the Augmented Dickey-Fuller (ADF) and Phillips-Perron unit root tests suggest that Bitcoin returns, the natural log of Bitcoin trading volumes, and the intensity of attention are all stationary (p-value < 1% for all).\(^5\)

\(^5\)Non-stationary variables can also be tested with the same algorithms using the lag-augmented VAR approach, as shown in Shi et al. (2020).
3.1 Bitcoin Returns

The results of time-varying causality tests running from the intensity of attention to COVID-19 news of the collectivistic and individualistic cluster to Bitcoin returns are displayed in Figures 1–2. As seen in Figure 1, one causal episode starting around January 01, 2020 exceeds its critical values across all panels, indicating that the null hypothesis of no Granger causality from the intensity of attention to COVID-19 news of the collectivistic country group to Bitcoin returns is rejected, while another causal episode starting around February 27, 2022 is detected by the recursive evolving algorithm under both homoskedastic and heteroskedastic assumption of the error term but not by the rolling algorithm. Yet a wider span of the causality is seen in Figure 2, using the individualistic cluster’s data, where the rolling and recursive evolving procedure present two and three episodes, respectively. Here, the causal effects happen around January 11, 2021, June 12, 2021, and July 25, 2021 that are quite different from the origination dates of the collectivistic country group.
Figure 1: Tests for Granger causality running from the intensity of attention to COVID-19 news to Bitcoin returns (collectivism).
Notes: The test statistic sequence (−) is in blue; the 5% bootstrapped critical value sequence (−) is in red. The selected lag order is 2.
Figure 2: Tests for Granger causality running from the intensity of attention to COVID-19 news to Bitcoin returns (individualism).
Notes: The test statistic sequence (—) is in blue; the 5% bootstrapped critical value sequence (–) is in red. The selected lag order is 2.


3.2 Trading Volumes

Figure 3: Tests for Granger causality running from the intensity of attention to COVID-19 news to trading volumes (collectivism).
Notes: The test statistic sequence (—) is in blue; the 5% bootstrapped critical value sequence (–) is in red. The selected lag order is 7.

In Figures 3–4, the results of Granger causality tests running from the intensity of attention to COVID-19 news of the collectivistic and individualistic cluster to Bitcoin trading volumes are visualized. As seen, both clusters present a more lasting causal relationship with trading volumes than with returns. However, both starting and end dates of causal effects between two country groups are still quite different. Specifically, a causal episode starting around June 01, 2021 is detected for the collectivistic cluster, while the origination date of the individualistic cluster is much earlier, dating back to, at least, July 01, 2020. Further, the recursive evolving procedure indicates that the effects of attention to COVID-19 news of two clusters on trading
volumes exist even now, while the rolling procedure shows a similar yet more fluctuating result. Overall, individualistic countries here still exhibit slightly stronger evidence of causality with trading volumes than collectivistic countries.

Figure 4: Tests for Granger causality running from the intensity of attention to COVID-19 news to trading volumes (individualism).
Notes: The test statistic sequence (—) is in blue; the 5% bootstrapped critical value sequence (–) is in red. The selected lag order is 7.

4 Conclusions

This paper examined the time-varying Granger causality between the intensity of real-time attention to country-specific COVID-19 news and daily Bitcoin returns and trading volumes. 12 countries representative of either the collectivism- or individualism-oriented culture were grouped into two clusters and examined separately. The main results are that a) although both
clusters present at least one causal episode, their timing and spans of the causality are quite different, and b) attention to COVID-19 news of the individualistic cluster, in general, presents stronger evidence of the causal relationship with the dynamics of the Bitcoin market. Findings revealed here add new insights to Bitcoin literature on COVID-19 and individualism.

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