



Gone with the fire: Market reaction to cryptocurrency exchange shutdown

Hanol Lee^a, Dainn Wie^{b,*}

^a Research Institute of Economics and Management, Southwestern University of Finance and Economics, 555, Liutai Avenue, Wenjiang District, Chengdu, Sichuan, 611130, People's Republic of China

^b National Graduate Institute for Policy Studies, B902, 7-22-1, Roppongi, Minato-ku, Tokyo, 106-8677, Japan

ARTICLE INFO

JEL classification:

G12
G14
G15
G23

Keywords:

Cryptocurrency
Abnormal return
Event study
Network service disruption

ABSTRACT

Disruption and shutdown of exchanges frequently happen in the cryptocurrency market, though its potential impacts are relatively under-investigated due to several empirical challenges. This study employs 20-h of service interruption on October 15th at *Upbit*, the dominant cryptocurrency exchange in Korea, as an exogenous shock to examine the effect of unexpected service interruption at the exchange on cryptocurrency market. Event study estimation using price data from *Binance*, the largest cryptocurrency exchange globally, shows the sharp and negative reactions to cryptocurrencies mostly traded at *Upbit*. Major currencies such as Bitcoin and Ethereum also presented limited reactions, implying that service interruption could be interpreted as vulnerability of overall cryptocurrencies.

1. Introduction

During October 15–16 2022, a fire at the main data center of *KakaoTalk*, the most popular messenger application in Korea, caused service disruption of *Upbit*, the dominating cryptocurrency exchange in Korea.¹ As *Upbit* users who use Android based smartphone could access the service only through *KakaoTalk* authentication, majority of users were not able to trade during 20-h of *KakaoTalk*'s service disruption.²

In the cryptocurrency market, disruption and shutdown of exchanges happen frequently [1,2]. The interruptions of service are mainly due to scheduled or unscheduled maintenance, unexpectedly excess network traffics, or cyberattacks. Despite its frequent occurrence and potential impacts on the cryptocurrency market, its causal impact on the market is relatively unknown for several empirical challenges. First, most maintenances would be pre-announced and allow traders to respond to the platform outages in advance, distilling the impact. Service interruptions are also often endogenous and driven by cryptocurrency market's situation. Huge trading volume often causes network failure which makes it difficult to separately estimate the impact of service interruptions from prior movements of prices and volatility in the market. Government regulation or the huge event which caused the full or partial

* Corresponding author.

E-mail addresses: hanollee@swufe.edu.cn (H. Lee), wie-dainn@grips.ac.jp (D. Wie).

¹ In 2022, *Upbit*'s market share in Korea was around 78.3%. <https://cointelegraph.com/news/korean-crypto-exchanges-are-now-in-compliance-with-the-travel-rule>.

² Users for Apple devices, could access the service through Apple identification. However, PC and Android based smartphone were supposed to receive verification code via *KakaoTalk* to access *Upbit*, which was impossible during the 20-h of disruption. As of September 2022, the share of PC and Android users in Korea is 74.64%. <https://gs.statcounter.com/os-market-share/all/south-korea>.

<https://doi.org/10.1016/j.heliyon.2023.e18231>

Received 20 December 2022; Received in revised form 7 July 2023; Accepted 12 July 2023

Available online 14 July 2023

2405-8440/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

market down have direct impacts on the valuation of cryptocurrency [3] as well as service interruptions, making it difficult to identify the sole impact of service interruptions.

In this study, we overcome estimation challenges by utilizing unique event of service interruptions caused by fire at the data center for *KakaoTalk* service on October 15th, 2022 in South Korea. The event was entirely driven by unexpected fire at data center. The major disruption caused by the fire at the data center was interruption in messenger application *KakaoTalk*, which people use for daily communication, taxi reservation, and shopping. Concerning that the event happened on Saturday, it is unlikely that *KakaoTalk* suspension had any impact on the market through disruptions in the real economy. Cryptocurrency traders are on average, younger and familiar with various information and communication technology. It is unlikely that the amount of information and communication among cryptocurrency traders were affected by the *KakaoTalk* disruption. However, a substantial proportion of cryptocurrency market users who had to log on to *Upbit* via *KakaoTalk*, were unable to trade as a result of the fire.

It is difficult to predict the impacts of service interruption based on existing theories. According to the valuation theory, the service interruption implies the potential weakness of the exchange and cryptocurrencies mainly traded at *Upbit*. The interruption could then negatively impact the abnormal return of those cryptocurrencies like any other bad news in the market [4]. In contrast, it must have had a limited impact on major currencies widely traded in other exchanges. However, the service interruption prevented investors from adequately reacting to the market news during the 20-h window. The 20-h trading halts possibly influenced investor inattention, similar to weekend distraction reported by Ref. [5], thereby leading to subdued responses to the news.

Trading halts and exchange shutdowns are well-studied in the literature of finance. However, the characteristics of those events are quite different from the network interruption reported in this study. Trading halts at the stock exchanges are often determined for regulatory purposes to facilitate orderly trading [6–8], while market closure on weekends and holidays are pre-scheduled and expected [5,9].

Literature provides some evidence related to regulation on cryptocurrency exchanges and its impact on market. Chen and Liu [10] showed that trading ban in China had relatively no impact on Chinese investors' Bitcoin purchase, while Okorie and Lin [3] reported significant market reactions due to Chinese government's intervention on ICO (Initial Coin Offering). However, there is scanty literature which examined the impact of cryptocurrency exchange's shutdown or security breach on market, even though such potential and actual incidents have been well reported [1,2].

This study contributes to the literature by providing empirical evidence regarding service interruption at *Upbit*, one of the lively exchanges,³ and its impact on the market by examining abnormal return of affected cryptocurrencies at the world's largest exchange, *Binance*. Using event study methodology, the study reports heterogeneous reaction between worldwide major cryptocurrencies and *Upbit*-dominant cryptocurrencies.

The rest of paper is organized as follows. Section 2 provides detailed description of *KakaoTalk* service interruption and other events affected the market around that time. Section 3 presents data and methodology. Section 4 presents results and our interpretation. We conclude in Section 5.

2. KakaoTalk down on October 15, 2022

KakaoTalk application is the most dominating smartphone application that South Korean people use for daily conversation, work, and platform to be authorized to log on many other affiliated services. Starting in 2010, *KakaoTalk* has enjoyed its advantage as a leader in the market recording 47 million active users in South Korea by the end of 2021 [11], where its population is around 52 million.

On October 15 in 2022, the unexpected fire at its major data center started around 3:19pm (in Korea Standard Time) in the afternoon and the incident was reported to the fire station nearby around 3:33pm. Due to the fire, the power supply had to be suspended causing service interruption in *KakaoTalk* and authentication services to all the affiliated services. The access to *Upbit*, a major cryptocurrency exchange in South Korea, was also interrupted because Android users⁴ could access *Upbit* only through *KakaoTalk* authorization. *Upbit* announced service interruption around 3:46pm through its customer center. However, no alternative way to utilize the service was provided to its Android users.

Following fire suppression, relevant services were recovered in the early morning of October 16 in a staggered fashion. The authentication service through *KakaoTalk* was fully enabled around 11:00am on October 16. *Upbit* also announced the recovery of authentication service around 11:05am in the morning noting that other services including consultation and mobile payment service would be resumed subsequently.

The 20 h of interruption in service sharply suppressed traded volume of cryptocurrency through *Upbit*. The trading volume during 20 h of service interruption (from 3pm, October 15 to 11am, October 16) was around 61 million, exhibiting 94% decrease from 960 million, a traded volume during the same 20 h in previous day (from 3pm, October 14 to 11am, October 15). The trade volume during the same 20 h next day (from 3pm, October 16 to 11am October 17) slightly recovered to 113 million. The decline in the trading

³ According to the *CoinMarketCap*, the rank of *Upbit* out of the cryptocurrency exchanges around the world was 23 as of November 6th, 2022.

⁴ According to *statcounter*, Android has more than 65% of market share as mobile operating system. <https://gs.statcounter.com/os-market-share/mobile/south-korea>.

volume is drastic even after we consider the day of the week effect.⁵

In Fig. 1, we present the movement of total traded value in its logarithms around the service interruption on October 15th. The graphs clearly highlight the sharp decline in total traded value during and after the service interruption. The value of total trading gradually recovered since early morning on October 17th, Sunday.

3. Data and methodology

In *Upbit*, 114 cryptocurrencies are traded in Korean Won. An hour before the service interruption on October 15th, top sixteen cryptocurrencies accounted for 80% of the value of the traded amount in *Upbit*.⁶ They are WEMIX, BORA, Ripple, STEP, Bitcoin, Ethereum Classic, Ethereum, PlayDapp, Hehera, Cardano, JUST, TRON, Stratis, The Sandbox, Status, and Chiliz.

To disentangle the effects of service interruption on the abnormal return of cryptocurrencies traded at *Upbit* from the impact of reduced trade volume, we choose to examine the thirteen⁷ out of sixteen cryptocurrencies, which are also traded at *Binance*, the largest cryptocurrency exchange in the world. Price data in every 4-h interval is collected from [Tradingview.com](https://tradingview.com) from October 3rd, 7am, to 20th 3pm in 2022.

There is no consensus in estimating abnormal returns in the literature of cryptocurrency. To calculate the abnormal return, we adopt the most widely employed methodology where returns of security are assumed to have a stable relationship with the market return R_t^M , using the following equation known as “the market model” [12,13].

$$R_{it} = \beta_0 + \beta_1 R_t^M + \varepsilon_{it}, \tag{1}$$

R_{it} and R_t^M are a log of returns of cryptocurrency i and the market at 4-h interval t . Logarithms are employed for both to account for skewness and kurtosis in financial data [14]. The challenge is that there are no standard market indices available in the market of cryptocurrency. We employed one of the major market indices, the “Top 10 crypto index” made by *Eightcap*,⁸ to circumvent the issue.

It should be noted that there was major economic news released on 9:30pm, KST (Korean Standard Time) on October 14th: release of consumer price index (CPI) of United States.⁹ The news which has close relationship with interest rate decision by Federal Reserve rattled the various stock markets and cryptocurrencies. Therefore, we chose estimation window for equation (1) to be from October 3rd, 7am to October 10th, 7am, excluding the week of CPI release (see Fig. 2). Then, the abnormal return AR_{it} is calculated as difference between predicted return and actual return as equation (2):

$$AR_{it} = R_{it} - (\hat{\beta}_0 - \hat{\beta}_1 R_t^M). \tag{2}$$

We employ the widely used event study methodology to examine the impact of an unexpected event on a firm’s stock return [13]. It examines market reactions prior to and following an unexpected event, to identify abnormal returns that cannot be explained by normal market fluctuations. The methodology is the most straightforward way for causal inference without requiring any restrictions/assumptions other than a stable baseline period that serves as a counterfactual.

Specifically, we examine the dynamic impacts on abnormal returns of 13 cryptocurrencies arising from the one-day service interruption October 15th to 16th, as well as prior trends on October 14th. The sample period in this estimation is from October 3rd, 7am, to October 20th, 3pm (see Fig. 2). Then, we estimate the following specification:

$$AR_{it} = \alpha + \sum_{j=-8}^{j=-1} \gamma_j (Pre_j)_i + \sum_{j=0}^{j=4} \delta_j (D_j)_i + \sum_{j=5}^{j=11} \varphi_j (R_j)_i + C_i + dow_t + u_{it}, \tag{3}$$

where D_j is an indicator for each 4-h interval during the service disruption. For instance, $j = 0$ denotes the first 4 h of service disruption from October 15th, 3pm to 7pm, same day. The set of coefficients δ_j capture the evolution of the impacts of service disruption for 20 h. Similarly, R_j is a binary indicator for each 4-h interval after the service restoration on October 16th, 11am, except for R_{11} which indicates all the period after October 17th, 11am. The market reaction to service restoration will be reflected to the seven coefficients φ_j . The eight indicators denoted as Pre_j covers 32-h period from October 14th, 7am, to October 15th, 3pm, and its coefficient will mainly capture the movement in the market due to CPI release (see Fig. 2).¹

According to the specification, each coefficient in equation (3) captures the difference in the abnormal return compared to the baseline period not controlled in the model, that is from October 3rd, 7am, to October 14th, 7am. Fixed effects for each cryptocurrency, C_i , and day of the week fixed effects dow_t are all controlled to further currency’s unobserved characteristics and trends of abnormal returns depending on the trade volume across day of the week. Error terms are clustered within each 4-h interval to address

⁵ As October 15 was Saturday, the effect from the day of week cannot be ruled out. So, we examined the same statistics using the previous week’s data. For 20 h from Oct 7 to Oct 8, the trading volume was around 723 million and it declined to 354 million, and further decreased to 160 million next day.

⁶ We obtained the trading volume data of all the listed cryptocurrencies using *Upbit* Open Application Programming Interface (API). Detailed information of *Upbit* Open API is available at <https://global-docs.upbit.com/>.

⁷ Out of sixteen cryptocurrencies, WEMIX, BORA, and Status are excluded as these cryptos are not listed in *Binance*.

⁸ Data for the “Top 10 crypto index” is available at [Tradingview.com](https://tradingview.com).

⁹ The news was released at 8:30am on October 14th in Eastern Standard Time (EST).

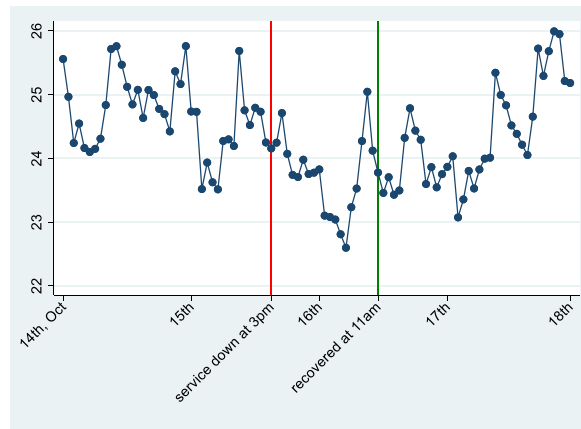


Fig. 1. Log of total traded value at Upbit from October 14th to October 17th.

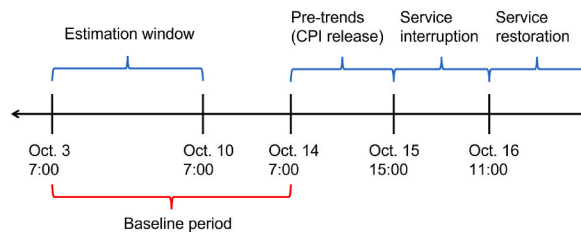


Fig. 2. Event timeline.

autocorrelation within the cluster.

4. Results and discussion

We estimated equation (3) and present all the estimated coefficients and its confidence intervals in Fig. 3. Abnormal returns started to plunge after the CPI release, reflecting how unexpected its figure was to the market. The dive stopped when US stock market closed at October 15, 5am in KST.

The abnormal return of thirteen cryptocurrencies then sharply declined again when service interruption began at 3pm, October 15th. The magnitude of the temporary decline in the abnormal return was close to that of the CPI release, implying huge reaction from the cryptocurrency traders regarding the service interruption. The sharp increase in abnormal return is then again observed in the very early morning of October 16th, when KakaoTalk service was partially resumed. The market reacted even before the official announcement from KakaoTalk and Upbit, when authentication service was gradually resumed. When the service was officially resumed, we do not observe much movement in the abnormal return.

We also tested the size and statistical significance of cumulative effects over several time windows in Table 1. Column (1) shows how the impact of CPI release is strengthened and dissipates over time during the 20-h window. Columns (2) and (3) demonstrate the accumulative effects of Kakao’s service interruption and resumption for several time windows for the same 20-h duration. It shows that the considerably negative impact of service interruption was dissipated over time, becoming statistically insignificant even before service resumption.

In Figs. 4 and 5, we divide thirteen cryptocurrencies in two groups and present comparison of movement of abnormal returns around the news. Fig. 4 shows that five worldwide major cryptocurrencies –Bitcoin, Ethereum, Ethereum Classic, Ripple, and Cardano tend to respond more to the economic news than disruption at Upbit. Fig. 4 highlights immediate and sharp decline in the abnormal return after CPI is released. These major cryptocurrencies did react to the service interruption at Upbit as well, though the magnitude of the reaction was much smaller compared to that for CPI release. However, these major cryptocurrencies did not react to the prospect of service resumption at Upbit or actual restoration of service, maintaining negative cumulative return during the service interruption as shown in Table 2.

In Fig. 5, we present how eight Upbit-dominant cryptocurrencies¹⁰ reacted to the CPI release, service interruption, and service restoration. It shows that these cryptocurrencies exhibited a larger negative abnormal return responding to the service interruption on

¹⁰ The share of their trade volume at Upbit out of total world volume is presented at Appendix Table A1 showing their considerable reliance on Upbit as a trade platform.

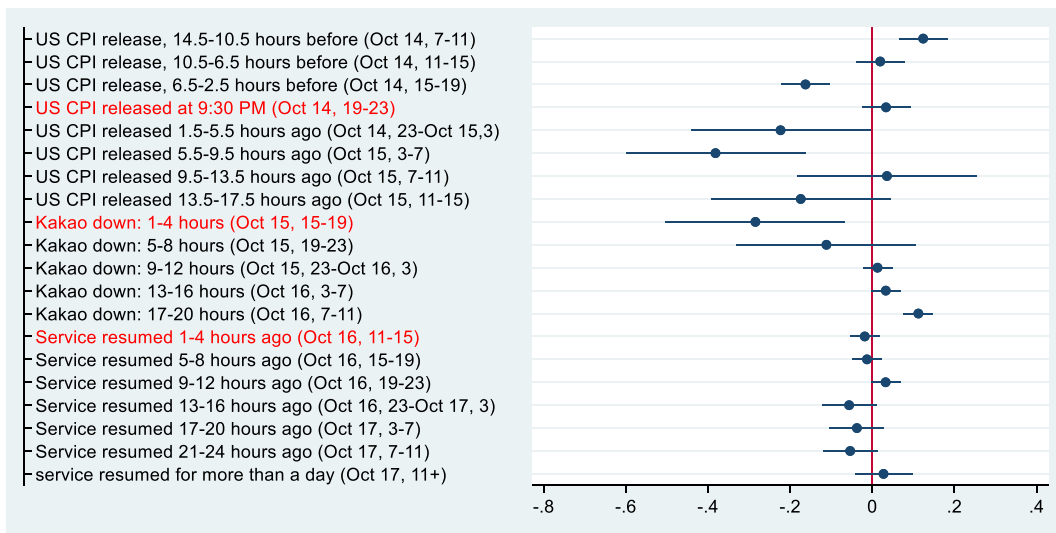


Fig. 3. Event study results: Abnormal return of thirteen *Upbit*-dominant cryptocurrencies at *Binance*.

Table 1
Cumulative effects over period: Thirteen *Upbit* Coins at *Binance*.

(1)		(2)		(3)	
Pre-event		Event: <i>Kakao</i> Down		Post-event	
14th, 7pm	-0.190*	15th, 3-11pm	-0.396*	16th, 11am	0.031
- 15th, 3am	(0.114)		(0.220)	- 7pm	(0.036)
14th, 7pm	-0.571**	15th, 3pm	-0.383*	16th, 11am	0.001
- 15th, 7am	(0.222)	-16th, 3am	(0.221)	- 11pm	(0.054)
14th, 7pm	-0.536	15th, 3pm	-0.350	16th, 11am	-0.055
- 15th, 11am	(0.331)	-16th, 7am	(0.223)	-17th, 3am	(0.063)
14th, 7pm	-0.710	15th, 3pm	-0.238	16th, 11am	-0.092
- 15th, 3pm	(0.441)	- 16th, 11am	(0.226)	- 17th, 7am	(0.086)
				16th, 11am	-0.146
				-17th, 11am	(0.114)
				16th, 11am	-0.119
				- 20th, 3pm	(0.128)

Note: ***, **, and * indicate statistical significance at 1%, 5%, and 10% respectively.

October 15th. The magnitude of the change in abnormal return is comparable to that for the CPI release, highlighting the significance of service interruption for these cryptocurrencies. Then, there was significant rebound in the abnormal return when *KakaoTalk*'s restoration was expected. Although the reaction was of a larger magnitude, the abnormal return quickly normalized mitigating cumulative effects over a longer time window as shown in [Table 3](#). The findings reported in this study are robust¹¹ when we use price data of these cryptocurrencies from other exchanges such as *Upbit* or *OKX*.

5. Conclusion

The year 2022 could be called a “crypto winter,” during which many investors lost their trust in cryptocurrencies. The collapse of Terra and the fall of FTX brought a crash in the market and a call for greater regulations in the future on exchanges’ transparency, reserve assets, and money laundry.

This study highlights the importance of stable service provision by empirically showing that cryptocurrencies dominantly traded in the exchange will experience negative abnormal returns during the service interruption. Investors using the exchange would be harmed as they cannot promptly react to sudden price changes due to service interruptions and other news in the market. We also provide suggestive evidence that even major cryptocurrencies reacted to the service interruption that happened at one of the many exchanges. However, the effects of other market news on these major currencies cannot be ruled out.

The empirical evidence presented in this study is unique in its setting showing only the impacts of unexpected service interruption. However, many factors remain unclear such as to what extent interruptions affect the market when the cause is cyberattacks or trading

¹¹ The replication data using alternative price information from those exchanges could be provided upon request.

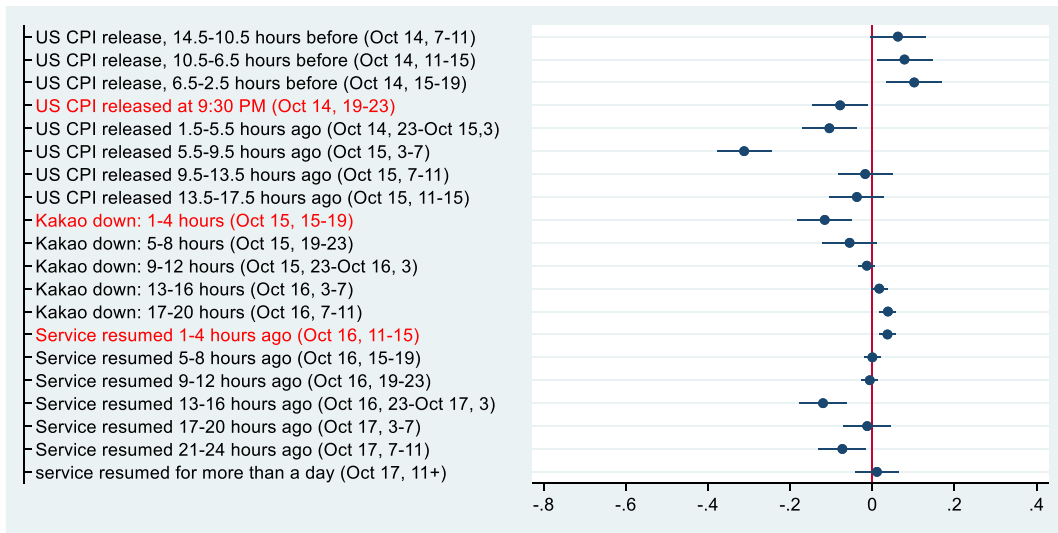


Fig. 4. Event study results: Abnormal Return of Five Worldwide Major Cryptocurrencies Dominant at Both *Upbit* and *Binance*.

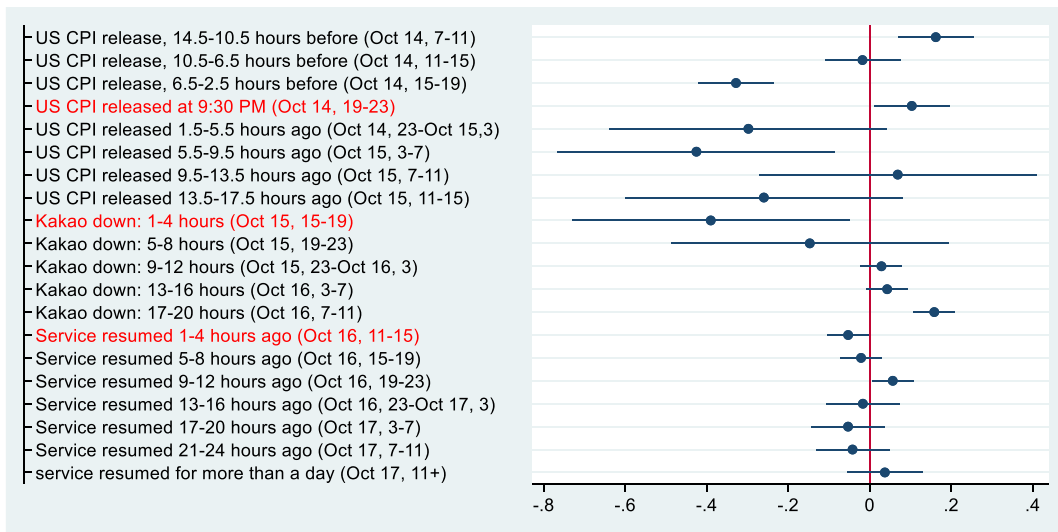


Fig. 5. Event study results: Abnormal Return of Eight *Upbit*-dominant Cryptocurrencies at *Binance* Excluding Five Worldwide Major Cryptocurrencies.

halts by exchange for other purposes. Future research is also required to investigate appropriate policy instruments and monitoring authorities to further improve the service and stability of cryptocurrency exchanges.

Author contribution statement

Hanol Lee: Conceived and designed the analysis; Analyzed and interpreted the data; Contributed analysis tools or data.

Dainn Wie: Conceived and designed the analysis; Analyzed and interpreted the data; Contributed analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Table 2Cumulative effects over period: Five Worldwide Major Cryptocurrencies Dominant at Both *Upbit* and *Binance*.

(1)		(2)		(3)	
Pre-event		Event: <i>Kakao</i> Down		Post-event	
14th, 7pm	-0.183***	15th, 3	-0.171**	16th, 11am	0.037*
- 15th, 3am	(0.048)	-11pm	(0.067)	- 7pm	(0.020)
14th, 7pm	-0.495***	15th, 3pm	-0.184***	16th, 11am	0.031
- 15th, 7am	(0.075)	-16th, 3am	(0.068)	- 11pm	(0.030)
14th, 7pm	-0.512***	15th, 3pm	-0.167**	16th, 11am	-0.089**
- 15th, 11am	(0.106)	-16th, 7am	(0.070)	-17th, 3am	(0.042)
14th, 7pm	-0.550***	15th, 3pm	-0.129*	16th, 11am	-0.101
- 15th, 3pm	(0.139)	- 16th, 11am	(0.074)	- 17th, 7am	(0.066)
				16th, 11am	-0.174*
				-17th, 11am	(0.092)
				16th, 11am	-0.163
				- 20th, 3pm	(0.103)

Note: ***, **, and * indicate statistical significance at 1%, 5%, and 10% respectively. These five major cryptocurrencies are Bitcoin, Ethereum, Ethereum Classic, Ripple, and Cardano.

Table 3Cumulative effects over period: Abnormal Return of Eight *Upbit*-dominant Cryptocurrencies at *Binance* Excluding Five Worldwide Major Cryptocurrencies.

(1)		(2)		(3)	
Pre-event		Event: <i>Kakao</i> Down		Post-event	
14th, 7pm	-0.194	15th, 3	-0.537	16th, 11am	-0.074
- 15th, 3am	(0.178)	-11pm	(0.344)	- 7pm	(0.051)
14th, 7pm	-0.619*	15th, 3pm	-0.508	16th, 11am	-0.017
- 15th, 7am	(0.347)	-16th, 3am	(0.345)	- 11pm	(0.077)
14th, 7pm	-0.551	15th, 3pm	-0.465	16th, 11am	-0.034
- 15th, 11am	(0.517)	-16th, 7am	(0.347)	-17th, 3am	(0.089)
14th, 7pm	-0.810	15th, 3pm	-0.307	16th, 11am	-0.087
- 15th, 3pm	(0.689)	- 16th, 11am	(0.352)	- 17th, 7am	(0.119)
				16th, 11am	-0.129
				-17th, 11am	(0.156)
				16th, 11am	-0.092
				- 20th, 3pm	(0.174)

Note: ***, **, and * indicate statistical significance at 1%, 5%, and 10% respectively. These *Upbit*-dominant cryptocurrencies are STEP, PlayDapp, Hehera, JUST, TRON, Stratis, The Sandbox, and Chiliz.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Appendix Table A1

Upbit-dominant Cryptocurrencies' share of traded value at *Upbit*
(as of October 14, 2022, in UTC)

	Traded value (\$)		Share of <i>Upbit</i>
	World	<i>Upbit</i>	
STEP	116,890,054	8,155,716	7.0%
PlayDapp	10,960,545	7,688,387	70.1%
Hehera	62,350,939	16,408,646	26.3%
JUST	118,629,347	27,920,555	23.5%
TRON	698,236,582	18,478,575	2.6%
Stratis	69,972,143	60,657,075	86.7%
The Sandbox	135,023,303	11,595,979	8.6%
Chiliz	214,999,289	18,204,444	8.5%

Notes: Traded value of World and *Upbit* are from *Coinmarketcap* and *Tradingview*, respectively.

References

- [1] A. Feder, N. Gandal, J.T. Hamrick, et al., The impact of DDoS and other security shocks on Bitcoin currency exchanges: evidence from Mt. Gox, *Journal of Cybersecurity* 3 (2) (2018) 137–144, <https://doi.org/10.1093/cybsec/tyx012>.
- [2] T. Moore, N. Christin, J. Szurdi, Revisiting the risks of bitcoin currency exchange closure, *ACM Trans. Internet Technol.* 18 (4) (2018) 1–18, <https://doi.org/10.1145/3155808>.
- [3] D.I. Okorie, B. Lin, Did China's ICO ban alter the Bitcoin market? *Int. Rev. Econ. Finance* 69 (2020) 977–993, <https://doi.org/10.1016/j.iref.2020.05.016>.
- [4] M. Hashemi Joo, Y. Nishikawa, K. Dandapani, Announcement effects in the cryptocurrency market, *Appl. Econ.* 52 (44) (2020) 4794–4808, <https://doi.org/10.1080/00036846.2020.1745747>.
- [5] S. Dellavigna, J.M. Pollet, Investor inattention and friday earnings announcements, *J. Finance* 64 (2) (2009) 709–749, <https://doi.org/10.1111/j.1540-6261.2009.01447.x>.
- [6] M.H. Hopewell, A.L. Schwartz, Stock price movement associated with temporary trading suspensions: bear market versus bull market, *J. Financ. Quant. Anal.* 11 (4) (1976) 577–590, <https://doi.org/10.2307/2330211>.
- [7] J.S. Howe, G.G. Schlarbaum, SEC trading suspensions: empirical evidence, *J. Financ. Quant. Anal.* 21 (3) (1986) 323–333, <https://doi.org/10.2307/2331045>.
- [8] C.M.C. Lee, M.J. Ready, P.J. Seguin, Volume, volatility, and New York stock exchange trading halts, *J. Finance* 49 (1) (1994) 183–214, <https://doi.org/10.1111/j.1540-6261.1994.tb04425.x>.
- [9] C.-W. Kim, J. Park, Holiday effects and stock returns: further evidence, *J. Financ. Quant. Anal.* 29 (1) (1994) 145–157, <https://doi.org/10.2307/2331196>.
- [10] C. Chen, L. Liu, How effective is China's cryptocurrency trading ban? *Finance Res. Lett.* 46 (2022), 102429 <https://doi.org/10.1016/j.frl.2021.102429>.
- [11] N. Jobst, Number of monthly active users of KakaoTalk in South Korea from 2nd quarter of 2015 to 4th quarter of 2021, Available from: 2022 <https://www.statista.com/statistics/746249/south-korea-kakaotalk-monthly-active-users>.
- [12] S. Armitage, Event study methods and evidence on their performance, *J. Econ. Surv.* 9 (1) (1995) 25–52, <https://doi.org/10.1111/j.1467-6419.1995.tb00109.x>.
- [13] A.C. MacKinlay, Event studies in economics and finance, *J. Econ. Lit.* 35 (1) (1997) 13–39. <https://www.jstor.org/stable/2729691>.
- [14] S.J. Brown, J.B. Warner, Using daily stock returns: the case of event studies, *J. Financ. Econ.* 14 (1) (1985) 3–31, [https://doi.org/10.1016/0304-405X\(85\)90042-X](https://doi.org/10.1016/0304-405X(85)90042-X).