Taming the blockchain beast? Regulatory implications for the cryptocurrency market.

SHANAEV, S., SHARMA, S., GHIMIRE, B. and SHURAEVA, A.

2020

Taming the Blockchain Beast? Regulatory Implications for the Cryptocurrency Market

Savva Shanaev[a*], Satish Sharma[a], Binam Ghimire[a], Arina Shuraeva[b]

[a] University of Northumbria at Newcastle, United Kingdom

[b] University of London, United Kingdom

[*] Corresponding Author: s.sharma@northumbria.ac.uk

Abstract

This paper uses a unique dataset of 120 regulatory events from five classes to test the relevance of the regulatory framework for cryptocurrency value. Time-series market-wide estimates and panel estimates for 300 individual coins and tokens show statistically and economically significant impact of anti-money laundering and issuance regulation. Tighter regulation and more active role of government decrease cryptocurrency prices, evidencing that potentially lower risks and wider adoption commonly attributed to the establishment of the regulatory framework do not compensate for respective efficiency and consumer utility losses. The market is generally efficient in reflecting regulatory information in cryptocurrency prices.

Keywords: cryptocurrency; cryptocurrency regulation; anti-money laundering; event studies

JEL codes: C32, C33, E42, G14, G18

Introduction and Literature Review

With the advent of blockchain technology in general and its most famous practical applications, cryptocurrencies, in particular, the issue of its regulation has been becoming increasingly relevant. Academics, policymakers, investors, and blockchain enthusiasts alike engage in the heated debate on what is the socially desirable level of cryptocurrency regulation. Some of the most vocal opponents, notably Nobel laureate Joseph Stiglitz, call for a complete cryptocurrency ban (Costelloe, 2017), while others advocate for a more or less flexible regulatory framework (Grinberg, 2011; Bollen, 2013; Atzori, 2015). On the other side of the opinion spectrum, it is argued that cryptocurrencies should not be regulated at all (Davidson and Block, 2015; Swan, 2015). The overall relevance of cryptocurrency regulation is overwhelmingly supported by the fact that even the Bank for International Settlements periodically issues thematic articles on the topic (e.g., Bech and Garrat, 2017; Auer and Claessens, 2018).

The heterogeneity of views on the issue and lack of consensus can be easily explained as cryptocurrencies present both significant technological advantages and sources of consumer value as well as notable and non-trivial challenges and concerns. As such, the potential consumer value of cryptocurrencies has been widely studied in terms of alternative money supply or payment service provision (Beer and Weber, 2015; Davidson and Block, 2015; White, 2015) and as substitutes for legal services and property rights definition (Swan, 2015; Karamitsos, Papadaki and Al Barghuthi, 2018). At the same time, cryptocurrencies are well-acknowledged tools used for tax evasion (Slattery, 2014), money laundering (Bryans, 2014), and illegal activity financing, with estimated 46% of Bitcoin transactions occurring in the grey sector of the economy (Foley, Karlsen and Putnins, 2019). Furthermore, significant market volatility and bubble-like behaviour (Fry, 2018) present risk concerns for individual investors and theoretically pose a systemic risk threat to the financial system as a whole. Finally, the

environmental impact of proof-of-work cryptocurrencies and the energy-intensive mining process essential for the functioning of the network has been cited as a potential source of negative externalities (Truby, 2018).

The lack of the regulatory focus of theoretical and empirical research on cryptocurrencies has been highlighted in the early foundational papers in the field (Dwyer, 2015). Recent systematic analyses of cryptocurrency-related academic sources still concede that the existing literature, particularly on regulatory issues, is rather limited, inconclusive and immature (Corbet et al., 2019). Overall, the participants of the cryptocurrency regulation debate can be classified into two broad stylised categories: “mainstream risk-averse regulation bulls” and “crypto-anarchist regulation bears”. Members of the first broad group generally estimate the expected gains associated with reduced volatility and increased adoption due to the establishment of the regulatory framework to exceed the potential efficiency losses (Grinberg, 2011; Bollen, 2013; Bryans, 2014; Böhme et al., 2015; Auer and Claessens, 2018), while the representatives of the second group generally presume the opposite. Furthermore, the “crypto-anarchists” tend to claim that government regulation of blockchain technologies and cryptocurrencies, in particular, contradicts the initial idea of decentralisation, blockchain-based payment networks being effectively a "real hedge" against potentially too intrusive government, while some regulatory measures, e.g. know-your-customer procedures, partially compromise essential technological solutions of blockchain such as pseudonymity. Ultimately, it is argued that blockchain technologies can facilitate sufficient substitutes for services currently monopolised by the government, both regarding money supply provision (Beer and Weber, 2015; Davidson and Block, 2015; White, 2015) and contract enforcement, e.g. property rights definition (Atzori, 2015; Karamitsos, Papadaki and Al Barghuthi, 2018).

Obviously, to discuss the impact of regulation on cryptocurrency value one should understand to which extent government action can influence the blockchain payment systems

in the first place. As cryptocurrencies implement various security solutions to make transaction tracking and the association between physical, legal and digital persons prohibitively hard, the question whether state regulation can, if desired so, effectively restrain blockchain payment systems is a valid and a non-trivial topic to investigate. It is also a relevant issue given the fact that while regulation is a predominantly national matter, cryptocurrencies are necessarily exterritorial (Auer and Claessens, 2018). For example, as there are multiple exchanges contributing to cryptocurrency price discovery with the same pairs traded in different jurisdictions (Brandvold et al., 2015), national exchange regulation might be extremely ineffective. Addressing these concerns, Hendrickson and Luther (2017) show that banning cryptocurrencies is feasible via the combined implementation of transaction policies and sufficiently harsh punishments for use. Therefore, regulation, at least theoretically, can have a significant impact on the consumer value of blockchain payment systems and, consequently, on the market prices of cryptocurrencies. Auer and Classens (2018) in a similar manner speculate that cryptocurrency regulation can be effective, especially if it is enforced internationally.

The only existing article on the market response to cryptocurrency regulation (Auer and Claessens, 2018) considers Bitcoin price reaction to 151 different regulatory events from January, 2015 until June, 2018. It asserts that the market reacts positively to advancements in the establishment of cryptocurrency regulatory framework and to legal recognition of cryptocurrencies as special asset classes, while bans, use restrictions and treatment as securities trigger negative price movements (Auer and Classens, 2018), therefore providing some early evidence in favour of the balanced approach to cryptocurrency regulation. Nevertheless, Auer and Classens (2018) utilise solely the Bitcoin return to derive its conclusions, while it is an established fact in the event study methodology literature that, when possible, such research should be undertaken on an aggregated portfolio basis by computing exposures of assets to

various relatively homogeneous event classes (Brock and Warner, 1985; McKinlay, 1997). Some early event studies for the cryptocurrency market indeed resorted to inferences from single currency price movements due to data unavailability or high event specificity (see, for example, Civitarese (2018) for the event study on the impact of technological news on coin prices). However, since there are currently hundreds of cryptocurrencies being traded on the market, this approach has been successfully utilised in Corbet et al. (2017) and Shanaev et al. (in press) for monetary policy news announcements and 51% attacks. Notably, the portfolio approach and large samples (100 digital assets) has also allowed Corbet et al. (2017) to detect heterogeneities in price reactions to macroeconomic news – they show that while digital currencies are quite responsive to monetary policy announcements, protocols and dApps are not. The issue of heterogeneous crypto-asset price reactions to various shocks has also been reinforced by Ciaian and Rajcaniova (2018) for the case of macro-financial indicators (e.g. gold, currency and stock market benchmarks), finding that altcoins are more exposed to these factors than Bitcoin.

The incorporation of the regulatory factor into the analysis of returns and risk exposures of this emerging asset class fills a considerable gap in the literature identified both by systematic literature analyses (Corbet et al., 2019) and by the recent empirical studies, showing little or no connection between cryptocurrency returns and established asset markets or risk factors (Corbet et al., 2018; Lee et al., 2018; Liu and Tsyvinski, 2018; Liu, Tsyvinski and Wu, 2019; Wang et al., in press). In case of general political factors, the evidence in the literature is mixed and conditional on the utilised metric of political risk: in case of economic policy uncertainty, the spillovers into the cryptocurrency markets are negligible, and crypto-assets can be employed as diversifiers (Wang et al., in press), while for geopolitical risks, negative innovations lead to higher returns, implying the hedging potential of cryptocurrencies (Aysan et al., 2019). Therefore, it becomes even more relevant to study the influence of market-specific regulatory

risk on the market prices of cryptocurrencies. As discussed above, the event study methodology was shown to be successfully applicable to the analysis of cryptocurrency performance (Corbet et al., 2017; Civitarese, 2018; Shanaev et al., in press). The most challenging aspect of such analysis is the accurate identification of event classes, which, unlike in the case of 51% attacks, can prove itself challenging in the context of regulatory news and announcements.

Data and Methodology

Due to the lack of systematised secondary data on the issue of cryptocurrency regulation, the study has resorted to manual primary data collection from a range of reputed traditional media sources such as Bloomberg, Reuters, BBC and Financial Times. For the sample period from 1st January 2017 until 18th March 2019, an extensive sample of 120 regulation-related news events has been formed. Content analysis techniques have been applied to the qualitative data gathered and common themes have been identified using the analysis of keywords and collocations. Five main broad topics of government and international cryptocurrency regulation are established and all of the regulatory events are allocated among these five categories: anti-money laundering, exchange regulation, issuance regulation, risk concerns and state-backed issuance. Following Auer and Claessens (2018), each of the events then has been assigned a sentiment dynamic binary variable of either positive (+1) or negative (-1).

Anti-money laundering facet of cryptocurrency regulation is mainly concerned with state and monetary authorities seeking to combat cryptocurrency-driven tax evasion and money laundering schemes and involves a wide mix of policy measures from cryptocurrency bans to tracking to official registration of cryptocurrency wallets. The negative (positive) dynamic here implies tightening (loosening) of the respective regulatory framework.

Exchange regulation covers all policy measures regarding cryptocurrency exchanges. These institutions can be considered a narrow and vulnerable spot of the blockchain network,

as exchange operations are easier to track and influence, therefore exchange regulation might be seen as a first step in the restriction of cryptocurrency use. Related to this facet of cryptocurrency regulation, positive sentiment includes new exchange approval and laissez-faire attitude towards exchanges while negative dynamic means license withdrawal, business improvement orders or legal actions taken against exchange operations. Unlike Auer and Claessens (2018), who treat anti-money laundering and exchange regulation homogeneously, this study has enough event data to study these event classes separately.

Issuance regulation consists of the policy implications of cryptocurrency finance and fundraising, most notably, initial coin offerings (ICOs), and the development of the legal status of cryptocurrencies as either financial assets, currencies or property. Here, ICO bans, tighter regulation of cryptocurrency funding, rejection of cryptocurrency-related ETFs and ETPs as well as legal recognition of cryptocurrencies as securities (making these assets subject to SEC regulation in the US) are interpreted as negative events while a generally hands-off approach to ICOs and approval of new cryptocurrency-backed financial instruments is considered positive. This definition of regulatory event class is consistent with Auer and Claessens (2018).

Risk concerns revolve around the public expression of government officials' attitude towards investment qualities or social value of cryptocurrencies as well as their formal endorsement, criticism or investment advice. Regarding risk concerns, positive and negative attitudes towards various characteristics of cryptocurrencies contribute to positive and negative regulatory sentiment, respectively.

Finally, *state-backed issuance* considers the development of sovereign coins, i.e. cryptocurrencies directly controllable by the monetary or state authorities of a particular country (Bech and Garratt, 2017). Here, successful development of state-backed coins or announcement of respective plans or projects is regarded as positive, and development halts, project rejections, and general disapproval are contrastingly interpreted negatively.

Findings and Discussion

Table 1 below lists the full sample of 120 regulatory events allocated among five categories and with sentiment dynamic binary variable assigned to them while also providing raw market return and cross-coin return volatility on the event day. Table 2 further below shows how these events are spread across themes and jurisdictions simultaneously. Contingency analysis has produced a Chi-squared statistic of 168.36 significant at 1%, implying that different countries focus on various facets of the cryptocurrency regulatory framework development. Even from the descriptive presentation of data, it can be seen that US, UK and Japan, three leading jurisdictions in terms of relevant news jointly providing 59 out of 120 sample regulatory events, are concerned with issuance regulation, anti-money laundering and exchange regulation, respectively, while other countries, such as Russia, Estonia, Iran, Venezuela and Marshall Islands focusing entirely on sovereign coin issuance.

Table 1. Full sample of regulatory events (01/01/2017 – 18/03/2019).

Date	Country	Brief event description	Regulatory event class	Dynamic	Market return	Volatility
11/03/2017	US	SEC: Bitcoin ETF proposal rejected	Issuance regulation	Negative	6.67%	15.12%
01/06/2017	China	Chinese exchange allows cryptocurrency withdrawals, moratorium ends	Exchange regulation	Positive	8.17%	15.22%
06/06/2017	Russia	Putin meets Buterin, wants to create state-backed coin based on Ethereum	State-backed issuance	Positive	5.17%	16.25%
26/07/2017	US	SEC: ICOs must abide by federal securities' laws	Issuance regulation	Negative	-1.28%	10.80%
01/08/2017	Russia	Banks start using Ethereum-based blockchain to process payments	State-backed issuance	Positive	1.68%	14.24%
08/08/2017	Russia	Russia plans and ICO of a state-backed cryptocurrency	State-backed issuance	Positive	4.47%	22.66%
17/08/2017	Australia	Australia plans to tighten AML crypto regulation	Anti-money laundering	Negative	1.90%	23.12%
22/08/2017	Estonia	State-backed "Estcoin" cryptocurrency proposed	State-backed issuance	Positive	3.61%	15.24%
04/09/2017	China	ICO ban	Issuance regulation	Negative	-11.34%	31.92%
07/09/2017	Estonia	Mario Draghi criticises Estcoin	State-backed issuance	Negative	0.70%	41.18%
08/09/2017	Russia	Russia will regulate cryptocurrencies as securities	Anti-money laundering	Negative	-9.04%	11.63%
14/09/2017	Russia	Central Bank of Russia: Cryptocurrencies are not a good idea	Risk concerns	Negative	-21.12%	46.62%
15/09/2017	China	Cryptocurrency exchanges ordered to wind down their operations	Exchange regulation	Negative	15.88%	15.68%
29/09/2017	South Korea	ICO ban	Issuance regulation	Negative	-1.34%	41.32%
29/09/2017	Japan	Japan: endorsement to 11 cryptocurrency exchanges	Exchange regulation	Positive	-1.34%	41.32%
10/10/2017	Russia	CBR: Websites selling cryptocurrencies will be blocked	Anti-money laundering	Negative	1.14%	28.20%
15/10/2017	UK	FCA warns retail traders against cryptocurrencies	Risk concerns	Negative	-1.68%	9.63%
24/10/2017	Singapore	Singapore is not planning to regulate cryptocurrencies	Risk concerns	Positive	-1.67%	44.57%
04/12/2017	UK	UK: money laundering concerns	Anti-money laundering	Negative	4.06%	19.69%
04/12/2017	UK	Treasury considers Bitcoin regulation due to money laundering concerns	Anti-money laundering	Negative	4.06%	19.69%
11/12/2017	US	Bitcoin futures start trading on CBOE	Issuance regulation	Positive	11.32%	16.90%
12/12/2017	US	US regulators warn cryptocurrency investors of potential risks	Risk concerns	Negative	10.85%	16.67%
13/12/2017	South Korea	Plans to tax capital gains from cryptocurrency trading	Risk concerns	Negative	-0.85%	17.29%
14/12/2017	UK	FCA sees no systematic risk in bitcoin and no need to regulate it	Risk concerns	Positive	9.44%	16.67%
16/12/2017	South Korea	North Korea hacking South Korean cryptocurrency exchanges	Anti-money laundering	Negative	9.34%	39.15%
18/12/2017	Germany	Germany joins France for G-20 based cryptocurrency regulation	Anti-money laundering	Negative	5.79%	33.92%
20/12/2017	UK	Carney is not worried about the systemic risk of cryptocurrencies	Issuance regulation	Positive	2.60%	25.24%
22/12/2017	Belarus	Belarus creates a tax-free cryptocurrency hub	Anti-money laundering	Positive	-14.33%	15.11%
28/12/2017	South Korea	South Korea: tightening of cryptocurrency regulation is expected	Anti-money laundering	Negative	-5.41%	25.61%
02/01/2018	Russia	Russia considers a state-backed "cryptorouble"	State-backed issuance	Positive	9.80%	17.64%
03/01/2018	China	China will restrict electricity access to miners	Risk concerns	Negative	11.09%	18.75%
05/01/2018	UK	BoE clarifies it is not launching its own cryptocurrency	State-backed issuance	Negative	5.10%	38.22%
09/01/2018	Venezuela	Venezuela's parliament outlaws the sovereign cryptocurrency	State-backed issuance	Negative	-0.79%	15.99%
11/01/2018	South Korea	South Korea considers ban on cryptocurrency trading	Anti-money laundering	Negative	-9.06%	13.01%
15/01/2018	China	China banning cryptocurrency exchange substitutes	Exchange regulation	Negative	-3.28%	9.78%
15/01/2018	South Korea	Regulators uncertain whether cryptocurrency exchanges should be banned	Exchange regulation	Positive	-3.28%	9.78%
16/01/2018	Russia	Russia plans to let Bitcoin trade on official exchanges	Exchange regulation	Positive	-20.82%	8.31%
19/01/2018	Switzerland	Switzerland encourages ICOs	Issuance regulation	Positive	0.76%	10.02%
22/01/2018	South Korea	Anonymous cryptocurrency trades banned	Anti-money laundering	Negative	-5.04%	8.02%
25/01/2018	Nigeria	Nigeria's central bank warns against cryptocurrency risks	Risk concerns	Negative	-0.42%	13.53%
25/01/2018	UK	May calls to look seriously into crypto due to money laundering concerns	Anti-money laundering	Negative	-0.42%	13.53%
29/01/2018	Japan	Cryptocurrency exchange investigations after massive fraud	Exchange regulation	Negative	-4.38%	12.70%
30/01/2018	US	Cryptocurrency advertisement ban on Facebook	Issuance regulation	Negative	-11.53%	8.93%
30/01/2018	US	Bitfinex and Tether subpoenaed	Exchange regulation	Negative	-11.53%	8.93%
31/01/2018	South Korea	Finance minister promises exchanges will not be banned	Exchange regulation	Positive	2.55%	7.88%
31/01/2018	Hong Kong	Hong Kong plans to regulate cryptocurrencies	Anti-money laundering	Negative	2.55%	7.88%
01/02/2018	India	India: money laundering concerns	Anti-money laundering	Negative	-11.59%	7.22%
05/02/2018	UK	Virgin Money bans cryptocurrency purchases with its credit cards	Anti-money laundering	Negative	-17.18%	6.86%
05/02/2018	UK	Lloyds bans cryptocurrency purchases	Anti-money laundering	Negative	-17.18%	6.86%
06/02/2018	Switzerland	BIS: regulators might need to intervene into cryptocurrencies	Risk concerns	Negative	14.00%	10.26%
08/02/2018	EU	ECB calls for cryptocurrency regulation	Anti-money laundering	Negative	10.60%	7.75%
13/02/2018	Japan	Cryptocurrency traders sue Coincheck for cryptocurrency theft	Anti-money laundering	Negative	-3.12%	6.61%
13/02/2018	US	Western Union tests transactions with Ripple	Issuance regulation	Positive	-3.12%	6.61%
16/02/2018	Switzerland	Switzerland lays out "balanced approach" for ICO regulation	Anti-money laundering	Negative	1.44%	9.44%
20/02/2018	Venezuela	State-backed "Petro" cryptocurrency issued	State-backed issuance	Positive	-2.57%	7.98%
21/02/2018	UK	MPs establish a committee for cryptocurrency investigation	Anti-money laundering	Negative	-5.79%	6.48%
21/02/2018	South Korea	Regulators want the cryptocurrency industry to become self-regulated	Exchange regulation	Positive	-5.79%	6.48%
22/02/2018	France	French regulators restrict cryptocurrency trading	Anti-money laundering	Negative	-6.29%	6.77%
27/02/2018	China	China closing overseas cryptocurrency trading loopholes	Anti-money laundering	Negative	1.97%	6.59%
28/02/2018	US	SEC: Potentially fraudulent ICO issuers subpoenaed	Issuance regulation	Negative	-3.81%	9.10%
28/02/2018	Marshall Islands	The Marshall Islands plans to issue SOV sovereign cryptocurrency	State-backed issuance	Positive	-3.81%	9.10%
01/03/2018	Japan	Plans for self-regulatory authority for cryptocurrency exchanges	Exchange regulation	Positive	4.31%	21.70%
02/03/2018	UK	Carney calls for regulation of cryptocurrencies	Anti-money laundering	Negative	-0.37%	13.23%
07/03/2018	Japan	Business-improvement orders for Coincheck	Exchange regulation	Negative	-7.74%	12.70%
07/03/2018	UK	Bitcoin money laundering: Always Efficient LLP	Anti-money laundering	Negative	-7.74%	12.70%
08/03/2018	Japan	Japan suspends trade on Bitstation and FSHO exchanges	Exchange regulation	Negative	-5.91%	11.37%
13/03/2018	US	Cryptocurrency advertisement ban on Google	Risk concerns	Negative	-0.26%	6.84%
13/03/2018	Japan	Japan plans to push G20 on AML regulation for cryptocurrencies	Anti-money laundering	Negative	-0.26%	6.84%
14/03/2018	US	Crypto start-up founders convicted of fraud	Anti-money laundering	Negative	-10.85%	6.02%
16/03/2018	US	Bitcoin mining banned in Pattsburgh	Risk concerns	Negative	-0.24%	6.94%
19/03/2018	US	US bans transactions with Venezuela's sovereign cryptocurrency	State-backed issuance	Negative	7.16%	9.69%
20/03/2018	US	G20 countries agree to jointly monitor cryptocurrencies	Anti-money laundering	Negative	2.58%	7.75%
22/03/2018	Japan	Warning issued for Binance for operating without a license	Exchange regulation	Negative	-2.72%	7.46%
22/03/2018	France	France creates a legal framework for ICOs	Issuance regulation	Negative	-2.72%	7.46%
26/03/2018	US	Twitter bans cryptocurrency advertising	Risk concerns	Negative	-4.90%	8.15%
27/03/2018	US	Fed sceptical of Bitcoin value, considers it highly speculative	Risk concerns	Negative	-5.25%	11.60%
05/04/2018	India	RBI bans cryptocurrency purchases from bank accounts	Anti-money laundering	Negative	0.19%	5.60%
05/04/2018	Japan	Japan issues a blueprint of ICO rules	Issuance regulation	Negative	0.19%	5.60%
05/04/2018	Spain	Spain investigates potential tax evasion in cryptocurrencies	Anti-money laundering	Negative	0.19%	5.60%
17/04/2018	US	Exchanges asked to provide information on internal controls	Exchange regulation	Negative	-1.20%	9.19%
22/04/2018	Iran	Iranian Central bank bans cryptocurrency purchases from bank accounts	Anti-money laundering	Negative	0.52%	10.70%
23/04/2018	US	CFTC former chairman: XRP and Ether should be classified as securities	Issuance regulation	Negative	3.77%	10.45%
27/04/2018	US	Nasdaq and BoA CEOs call for crypto regulation as securities	Issuance regulation	Negative	-2.95%	7.83%
28/04/2018	Iran	Iran developing a local experimental government-backed cryptocurrency	State-backed issuance	Positive	6.19%	10.48%
24/05/2018	US	Cryptocurrency price manipulation investigation	Exchange regulation	Negative	3.09%	8.22%
01/06/2018	Estonia	Estonia scales down the Estcoin project	State-backed issuance	Negative	0.84%	8.92%
14/06/2018	US	SEC: Bitcoin and Ethereum are not securities	Issuance regulation	Positive	6.76%	7.31%
18/06/2018	France	Macron promises looser regulation for crypto projects	Issuance regulation	Positive	3.23%	6.81%

22/06/2018	Japan	Business-improvement orders for cryptocurrency exchanges	Exchange regulation	Negative	-11.01%	6.30%
26/06/2018	US	Facebook eases the cryptocurrency advertising ban	Risk concerns	Positive	-4.51%	6.74%
12/07/2018	Malta	Crypto investors plan to establish a regulated cryptocurrency bank	Issuance regulation	Positive	-3.19%	4.72%
19/07/2018	Switzerland	Switzerland seeks to relax crypto regulations	Anti-money laundering	Positive	-0.33%	5.84%
26/07/2018	Iran	Iran working on a state-backed cryptocurrency	State-backed issuance	Positive	-2.69%	6.85%
27/07/2018	US	SEC rejects Bitcoin ETF proposal	Issuance regulation	Negative	2.02%	6.22%
15/08/2018	US	US cryptocurrency investor sues AT&T for cryptocurrency theft	Anti-money laundering	Negative	1.76%	8.37%
22/08/2018	US	SEC: Nine Bitcoin ETFs rejected	Issuance regulation	Negative	-2.77%	6.55%
23/08/2018	US	Three Bitcoin ETF proposal rejected by SEC	Issuance regulation	Negative	2.85%	7.74%
05/09/2018	EU	Finance ministers: there should be common EU cryptocurrency regulation	Anti-money laundering	Negative	-11.10%	10.89%
11/09/2018	Marshall Islands	The Marshall Islands are warned against issuing sovereign cryptocurrency	State-backed issuance	Negative	-1.62%	9.31%
11/09/2018	US	SEC accuses three cryptocurrency projects of securities fraud	Issuance regulation	Negative	-1.62%	9.31%
18/09/2018	US	NY: three crypto exchanges might be operating illegally	Exchange regulation	Negative	3.60%	7.05%
19/09/2018	UK	MPs call for crypto regulation, compare the market to "Wild West"	Risk concerns	Negative	0.39%	6.70%
25/09/2018	US	Google relaxes the cryptocurrency advertising ban for US and Japan	Risk concerns	Positive	-1.66%	6.54%
26/09/2018	Switzerland	Former UBS bankers plan to establish a regulated cryptocurrency bank	Issuance regulation	Positive	0.75%	7.32%
15/10/2018	US	CFTC former chairman: most ICO tokens are securities	Issuance regulation	Negative	5.74%	9.33%
19/10/2018	EU	FATF proposed global cryptocurrency regulation for AML	Anti-money laundering	Negative	-0.02%	6.67%
24/10/2018	Japan	Cryptocurrency exchange industry gets official self-regulatory status	Exchange regulation	Positive	0.02%	8.69%
25/10/2018	UK	UK government blocks the Royal Mint's cryptocurrency project	State-backed issuance	Negative	-0.37%	8.73%
29/10/2018	UK	UK considers to ban cryptocurrency derivatives	Issuance regulation	Negative	-3.34%	8.22%
05/11/2018	Marshall Islands	No confidence vote over sovereign cryptocurrency	State-backed issuance	Negative	1.21%	9.33%
07/11/2018	France	Bitcoin taxes lowered	Risk concerns	Positive	-0.05%	12.30%
14/11/2018	US	Lagarde says central banks might issue their own digital currencies	State-backed issuance	Positive	-10.29%	11.94%
15/11/2018	EU	Bitcoin is "a bubble, a Ponzi scheme and an environmental disaster"	Risk concerns	Negative	-1.00%	24.22%
17/11/2018	Switzerland	Switzerland: first cryptocurrency-backed ETP	Issuance regulation	Positive	0.11%	5.95%
19/11/2018	US	SEC ordered ICO companies to register tokens and compensate investors	Issuance regulation	Negative	-13.06%	7.13%
14/12/2018	Marshall Islands	Sovereign cryptocurrency project is delayed but continued	State-backed issuance	Positive	-2.88%	6.36%
07/01/2019	Japan	FSA declines crypto futures but may legalise ETFs in the future	Issuance regulation	Negative	-1.71%	9.14%
14/02/2019	US	JP Morgan creates first bank-backed cryptocurrency	Issuance regulation	Positive	-0.79%	8.42%
20/02/2019	Bahrain	Bahrain plans to regulate cryptocurrencies	Anti-money laundering	Negative	2.23%	11.85%
26/02/2019	Malta	Malta develops a full crypto regulatory framework for ICOs	Issuance regulation	Negative	-0.90%	7.01%

Table 2. Regulatory events across event classes and jurisdictions.

Country	Anti-money laundering	Exchange regulation	Issuance regulation	Risk concerns	State-backed issuance	Total	%
US	3	4	16	7	2	32	26.67%
UK	8	0	2	3	2	15	12.50%
Japan	2	8	2	0	0	12	10.00%
South Korea	4	3	1	1	0	9	7.50%
Russia	2	1	0	1	4	8	6.67%
China	1	3	1	1	0	6	5.00%
Switzerland	2	0	3	1	0	6	5.00%
EU	3	0	0	1	0	4	3.33%
Marshall Islands	0	0	0	0	4	4	3.33%
France	1	0	2	1	0	4	3.33%
Iran	1	0	0	0	2	3	2.50%
Estonia	0	0	0	0	3	3	2.50%
India	2	0	0	0	0	2	1.67%
Venezuela	0	0	0	0	2	2	1.67%
Malta	0	0	2	0	0	2	1.67%
Bahrain	1	0	0	0	0	1	0.83%
Germany	1	0	0	0	0	1	0.83%
Belarus	1	0	0	0	0	1	0.83%
Spain	1	0	0	0	0	1	0.83%
Australia	1	0	0	0	0	1	0.83%
Hong Kong	1	0	0	0	0	1	0.83%
Singapore	0	0	0	1	0	1	0.83%
Nigeria	0	0	0	1	0	1	0.83%
Total	35	19	29	18	19	120	
%	29.17%	15.83%	24.17%	15.00%	15.83%		

The regulatory impact on cryptocurrency value is estimated in two frameworks: on an aggregated (market) level, using an equal-weighted and a value-weighted cryptocurrency market return index and on an individual cryptocurrency level, utilising a panel of 300 coin and token returns. Daily returns for the sample period from 1st January 2017 until 18th March 2019 have been calculated using Coinmarketcap data and used to construct both the equal-weighted (simple average) and the value-weighted (market capitalisation weighted) cryptocurrency portfolios serving as market proxies on the first stage of the analysis. Both approaches code regulatory events using event class-specific dummy variables, 0 being no relevant event in the day of interest, 1 denoting a positive event and -1 denoting a negative event. All sample events and their theoretical impact on the regulatory environment of cryptocurrencies are presented in Table 1. As the events are identified and verified using reliable news sources, all 120 sample events are considered theoretically relevant, i.e., coded as +1 or -1. The definition of positive and negative regulatory change with regards to the five facets of cryptocurrency regulation can be consulted in greater detail in Data and Methodology section above.

The market-wide impact of regulation is estimated in three time-series models: standard OLS regression, GARCH (1,1) model and AR model. The number of lags in the AR model is chosen based on the serial correlation properties identified with the regular LM test. To measure regulatory effect on individual coins, a panel data model is used, estimating a pooled regression, a Fixed Effects and a Random Effects model, each with ordinary, period-clustered seemingly unrelated regression (Zellner, 1962) and two-way clustered (Petersen, 2009) standard errors, as in Campbell et al. (2003) and Shanaev et al. (in press). To choose from three feasible panel data models, first the redundant Fixed Effects F-test is applied to determine whether pooled regression can be improved upon, and then Hausman test (Hausman, 1978) is utilised to determine if the Random Effects estimators are consistent.

Tables 3a-3d and 4 below report the results of the estimations of time-series and panel data models, respectively. For the time-series models, GARCH (1,1) variance regressors were both statistically significant and economically meaningful (positive and summing up to less than 1). The LM test identified that the proper amount of lags for the AR model is two, and in the AR model, all the roots had an absolute value of less than unity. Therefore, the results of all three time-series models are interpretable. Next, as in Ciaian and Rajcaniova (2018), potential heterogeneities in cryptocurrency price responses across proof-of-work, proof-of-stake coins and tokens are studied. Consistently, for the equal-weighted and value-weighted portfolios across proof-of-work coins, proof-of-stake coins, tokens and market as a whole, the development of issuance and anti-money laundering regulation generates a negative response in the cryptocurrency market index, while the relaxation of this regulation is associated with positive abnormal returns. Exchange regulation and state-backed issuance are significant or marginally insignificant in some estimations, particularly for proof-of-work coins, making it unclear whether the market reacts to those events, while cryptocurrency risk concerns and risk-related policy propositions cause no market movements.

Table 3a. Regulatory effect on cryptocurrency value on the aggregate (market) level.

Regressor	Equal-weighted portfolio			Value-weighted portfolio		
	OLS	GARCH	AR	OLS	GARCH	AR
Constant	1.2914***	1.0888***	1.2964***	0.6330***	0.5598***	0.6440***
	(0.0000)	*(0.0000)*	*(0.0000)*	*(0.0002)*	*(0.0002)*	*(0.0007)*
Anti-money laundering	1.9918*	2.3516***	2.2071***	2.0395**	2.0319***	2.3461***
	(0.0632)	*(0.0040)*	*(0.0032)*	*(0.0161)*	*(0.0018)*	*(0.0001)*
Exchange regulation	1.2823	1.1030	0.9153	0.8148	0.9888	0.7585
	(0.3601)	*(0.1935)*	*(0.3017)*	*(0.4615)*	*(0.1597)*	*(0.2631)*
Issuance regulation	2.6440**	2.4788***	2.7646**	2.1937**	1.5703**	2.3321***
	(0.0170)	*(0.0095)*	*(0.0106)*	*(0.0122)*	*(0.0162)*	*(0.0053)*
Risk concerns	0.0252	0.6382	-0.1980	0.1075	0.3586	0.0014
	(0.9857)	*(0.5738)*	*(0.8543)*	*(0.9228)*	*(0.6347)*	*(0.9984)*
State-backed issuance	-1.3800	-1.5222	-1.6560	-0.2860	-0.6420	-0.3610
	(0.3105)	*(0.2498)*	*(0.1453)*	*(0.7898)*	*(0.3973)*	*(0.7505)*
R^2	0.0129	0.0111	0.0267	0.0147	0.0136	0.0237

Table 3b. Regulatory effect on cryptocurrency value for proof-of-work coins.

Regressor	Equal-weighted portfolio	Value-weighted portfolio

	OLS	GARCH	AR	OLS	GARCH	AR
Constant	1.1288***	0.8120***	1.1131***	0.4760***	0.4780***	0.4838***
	(0.0000)	*(0.0001)*	*(0.0005)*	*(0.0033)*	*(0.0000)*	*(0.0049)*
Anti-money laundering	1.6239	1.3591*	1.7566**	1.9725**	2.0321***	2.1670***
	(0.1225)	*(0.0905)*	*(0.0155)*	*(0.0155)*	*(0.0000)*	*(0.0000)*
Exchange regulation	0.7537	1.2332	0.4671	0.7575	1.1700***	0.7422
	(0.5833)	*(0.1886)*	*(0.6098)*	*(0.4763)*	*(0.0024)*	*(0.2837)*
Issuance regulation	2.7519**	2.2727***	2.8129***	2.0113**	1.6902***	2.0992**
	(0.0113)	*(0.0039)*	*(0.0061)*	*(0.0168)*	*(0.0000)*	*(0.0117)*
Risk concerns	1.1472	1.5801*	0.9266	0.6718	0.2400	0.6480
	(0.4049)	*(0.0972)*	*(0.3650)*	*(0.5286)*	*(0.5990)*	*(0.3926)*
State-backed issuance	-1.7407	-1.9653**	-1.9547	-0.5841	-1.0618**	-0.6965
	(0.1923)	*(0.0301)*	*(0.1398)*	*(0.5717)*	*(0.0243)*	*(0.4864)*
R^2	0.0138	0.0104	0.0216	0.0151	0.0143	0.0183

Table 3c. Regulatory effect on cryptocurrency value for proof-of-stake coins.

Regressor	Equal-weighted portfolio			Value-weighted portfolio		
	OLS	GARCH	AR	OLS	GARCH	AR
Constant	1.4316***	1.1020**	1.4371***	1.3173***	0.8343**	1.3287***
	(0.0000)	*(0.0136)*	*(0.0070)*	*(0.0033)*	*(0.0121)*	*(0.0006)*
Anti-money laundering	2.2874	2.6591	2.4908*	1.5222	2.3221*	2.0165*
	(0.1407)	*(0.1001)*	*(0.0930)*	*(0.2646)*	*(0.0695)*	*(0.0522)*
Exchange regulation	2.1125	1.7988	1.8261	0.9396	0.5302	0.2610
	(0.2979)	*(0.2284)*	*(0.3225)*	*(0.5984)*	*(0.6893)*	*(0.8444)*
Issuance regulation	2.4141	2.1698	2.4952	2.9690**	2.8368**	3.1650**
	(0.1321)	*(0.2580)*	*(0.2611)*	*(0.0353)*	*(0.0422)*	*(0.0417)*
Risk concerns	-0.7410	-0.2396	-0.8927	-0.3106	0.6329	-0.6684
	(0.7156)	*(0.9253)*	*(0.7026)*	*(0.8621)*	*(0.6065)*	*(0.5331)*
State-backed issuance	-1.1127	-1.6672	-1.6268	-0.6048	-1.6489	-1.2603
	(0.5723)	*(0.5369)*	*(0.6141)*	*(0.7270)*	*(0.2953)*	*(0.4181)*
R^2	0.0069	0.0050	0.0216	0.0072	0.0011	0.0363

Table 3d. Regulatory effect on cryptocurrency value for tokens.

Regressor	Equal-weighted portfolio			Value-weighted portfolio		
	OLS	GARCH	AR	OLS	GARCH	AR
Constant	1.3675***	1.2588***	1.3719***	1.2362***	0.8510***	1.2408***
	(0.0000)	*(0.0000)*	*(0.0005)*	*(0.0000)*	*(0.0001)*	*(0.0001)*
Anti-money laundering	2.1924	2.2443*	2.3080*	2.1877	2.2258**	2.3746**
	(0.1404)	*(0.0966)*	*(0.0692)*	*(0.1035)*	*(0.0220)*	*(0.0233)*
Exchange regulation	0.7281	0.4748	0.4443	0.5310	1.1317	0.4720
	(0.7079)	*(0.7813)*	*(0.7761)*	*(0.7632)*	*(0.3186)*	*(0.7286)*
Issuance regulation	2.7815*	2.9220**	2.9210	3.0082**	2.4082***	3.0789**
	(0.0701)	*(0.0349)*	*(0.1040)*	*(0.0302)*	*(0.0043)*	*(0.0355)*
Risk concerns	-0.0901	-0.3132	-0.0823	-0.6468	0.0042	-0.7732
	(0.9631)	*(0.8877)*	*(0.9651)*	*(0.7133)*	*(0.9977)*	*(0.5429)*
State-backed issuance	-1.7474	-2.1036	-1.8986	-2.0952	-2.7496***	-2.0725
	(0.3547)	*(0.3085)*	*(0.4203)*	*(0.2194)*	*(0.0018)*	*(0.1816)*
R^2	0.0076	0.0073	0.0124	0.0106	0.0069	0.0154

Notes: in Tables 3a-3d, event class effect on cryptocurrency returns estimated in a time-series model using a dummy variable approach in standard OLS, GARCH (1,1) (Bollerslev, 1986) as well as AR models. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

The same pattern is replicated in the panel data models, showing there is no significant heterogeneity bias in the aggregate treatment of the cryptocurrency market. As the redundant Fixed Effects F-test has generated significant F-statistic, cross-sectional dummy variables meaningfully contribute to the explanatory power of the model, and therefore the Fixed Effects model is preferable to the pooled regression model. Consequently, the Hausman test has produced an insignificant Chi-squared statistic, evidencing that Random Effects estimator is consistent and can be used instead of the less efficient Fixed Effects estimator. Therefore, the study mainly opts to interpret the Random Effects model output, however, note that the results are outstandingly consistent across all three models. To further test if responses to regulatory events are different for proof-of-work, proof-of-stake coins and tokens, an omitted variable F-test was utilised to check if the addition of ten dummy interaction terms based on cryptocurrency type and event class significantly improve the model's explanatory power. A highly insignificant F-stat of 0.098 (p-value greater than 99%) has been obtained, showing that cryptocurrency price responses to regulation do not depend on cryptocurrency type (proof-of-work, proof-of-stake, coin with an unconventional consensus mechanism or token).

Table 4. Regulatory effect on cryptocurrency value on the individual coin level.

Regressor	Pooled regression			Fixed Effects model			Random Effects model		
	OLS	SUR	Two-way	OLS	SUR	Two-way	OLS	SUR	Two-way
Constant		1.6593			1.6573			1.4600	
	(0.0000)	*(0.0010)*	*(0.0000)*	*(0.0000)*	*(0.0000)*	*(0.0000)*	*(0.0008)*	*(0.0358)*	*(0.0003)*
Anti-money laundering		2.4956			2.4517			2.4561	
	(0.0093)	*(0.0000)*	*(0.0000)*	*(0.0104)*	*(0.0000)*	*(0.0000)*	*(0.0103)*	*(0.0000)*	*(0.0000)*
Exchange regulation		1.8392			1.7600			1.7760	
	(0.1445)	*(0.0000)*	*(0.0000)*	*(0.1612)*	*(0.0000)*	*(0.0000)*	*(0.1574)*	*(0.0000)*	*(0.0000)*
Issuance regulation		2.6748			2.6646			2.6655	
	(0.0046)	*(0.0000)*	*(0.0000)*	*(0.0047)*	*(0.0000)*	*(0.0000)*	*(0.0046)*	*(0.0000)*	*(0.0000)*
Risk concerns		-0.0740			-0.0640			-0.0680	
	(0.9528)	*(0.7854)*	*(0.8164)*	*(0.9590)*	*(0.8131)*	*(0.7892)*	*(0.9565)*	*(0.8003)*	*(0.8240)*
State-backed issuance		-1.7830			-1.8320			-1.8230	
	(0.1413)	*(0.0000)*	*(0.0000)*	*(0.1295)*	*(0.0000)*	*(0.0000)*	*(0.1313)*	*(0.0000)*	*(0.0000)*

R^2	0.0001	0.0090	0.0001

Notes: event class effect on cryptocurrency returns estimated in a panel data framework using a dummy variable approach. Standard errors are estimated using OLS, seemingly unrelated regression (SUR) approach (Zellner, 1962) as well as two-way volatility clustering assumption (Petersen, 2009).

In the estimation with robust heteroscedasticity-consistent standard errors, either from the seemingly unrelated regression model (Zellner, 1962) or with two-way volatility clustering (Petersen, 2009), four out of five regulation types are shown to significantly affect coin prices, anti-money laundering and issuance regulation again being most consistent.

For *anti-money laundering* policies, the implementation of new anti-fraud controls or the overall tightening of the regulatory framework produces an average negative abnormal return of 2.46%.

Regarding *exchange regulation*, the approval of new cryptocurrency exchanges and the generally hands-off regulatory framework contributes to the coin market prices positively, while active interventions such as business improvement orders, closures and legal investigations into the exchanges' operations are shown to reduce cryptocurrency value by 1.78% on average.

New *issuance regulation* measures, such as ICO bans, classification of cryptocurrencies as securities and rejections of cryptocurrency ETFs and ETPs generate an expected negative price response equalling 2.67%, while approval of new cryptocurrency-related instruments, relaxation of ICO regulations and recognition of cryptocurrencies as not being subject to SEC authority triggers a similar positive response.

Conversely, *risk concerns* and broad value judgements regarding cryptocurrencies publicly expressed by government officials are not priced on the cryptocurrency market at all, either positively or negatively, in any of the estimation frameworks. It might reflect the fact that the market does not believe cryptocurrencies are a potential systemic risk threat (Auer and Claessens, 2018).

Finally, optimistic news related to *state-backed issuance* of sovereign cryptocurrencies similarly decreases coin value by 1.82%, either due to expected complementarity between established cryptocurrencies and sovereign "challengers", generally more intrusive government attitude towards the industry or negative publicity generated by some of the least credible sovereign cryptocurrencies such as Venezuelan so-called "Petro". Contrastingly, the dismissals or discontinuations of state-backed cryptocurrency projects or heavy criticism addressed at them is evaluated positively by the market.

Overall, the results signal that the market perceives regulatory events as value-destroying, estimating efficiency and consumer value losses associated with the implementation of regulation higher than the potential reduction of risk and wider adoption. Therefore, the market implicitly prices current attempts regarding the development of cryptocurrency regulation as generally counterproductive.

To determine if the cryptocurrency market is efficient regarding the reflection of regulatory factors and as an additional robustness check, the study also estimates abnormal returns for each of the days in the event window [-2;2] using the constant return model in the panel regression framework with Random effects. The constant return model has been chosen as regulatory events potentially affect all cryptocurrencies simultaneously, so, unlike in case of 51% attacks (Shanaev et al., in press), there would be little reason to develop a cryptocurrency-specific market factor for event studies purposes. As for other potential market factors, e.g., broad stock market indices, they are consistently shown to not influence crypto-asset returns (Lee et al., 2018; Liu and Tsyvinski, 2018; Liu et al., 2019), so their relevance for these estimations is doubtable at best. Table 5 below presents the estimation results.

Table 5. Abnormal returns for various event classes across multiple event windows.

Event day	Anti-money laundering	Exchange regulation	Issuance regulation	Risk concerns	State-backed issuance
[-2;-2]	-0.8290	1.5613	-1.2340	0.2367	0.3933

	(0.3944)	*(0.2215)*	*(0.1992)*	*(0.8508)*	*(0.7507)*
[-1;-1]	-1.0440	0.7124	-0.2150	0.0037	-0.0190
	(0.2851)	*(0.6240)*	*(0.8237)*	*(0.9977)*	*(0.9879)*
[0;0]	2.4308**	2.1414*	3.0117***	-0.1040	-2.0620*
	(0.0128)	*(0.0977)*	*(0.0018)*	*(0.9346)*	*(0.0962)*
[1;1]	1.7902*	2.3501*	-0.9770	1.1930	0.7270
	(0.0695)	*(0.0687)*	*(0.3115)*	*(0.3497)*	*(0.5588)*
[2;2]	-0.5750	-0.2020	0.8231	1.6539	1.4435
	(0.5594)	*(0.8753)*	*(0.3940)*	*(0.1941)*	*(0.2394)*

Notes: abnormal cryptocurrency returns estimated in a panel data model with Random Effects using a dummy variable approach. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

The findings are generally consistent with the output of Tables 3a-3d and 4. Interestingly, there is notable underreaction to the anti-money laundering and exchange regulation news, some significant price adjustments being observable one day after the event. Nevertheless, the coin price responses on the event days themselves remain statistically significant and of signs consistent with previous results. Apart from underreaction, such market inefficiency case can also be explained by the high uncertainty and relative unreliability of most cryptocurrency-related news. Therefore, the market might require additional time to check if the regulatory announcement is reliable and adjust the price accordingly. Notably, there exists no such tendency for either issuance regulation events or state-backed issuance events, potentially due to the fact that they are easier to verify. The study has not found any abnormal returns on days preceding the event, therefore evidencing no noticeable anticipation effects, general unpredictability of regulatory events and absence of insider trading by regulators.

Conclusion

This study has estimated the impact of five broad regulatory event classes on the cryptocurrency market, using manually collected data on 120 events and a sample of 300 coins and tokens on a daily basis. Having applied various event studies techniques in the time-series and panel data models, it has shown that news associated with the tightening and, generally, further development of anti-money laundering, exchange and issuance regulation as well as news on the successful launch of state-backed sovereign cryptocurrencies have a statistically and

economically significant negative effect on the market. Further, the relaxation of the respective policy measures and the declaration of hands-off, self-regulatory approach as well as rejections or heavy critiques of state-backed blockchain payment system projects, contrastingly, lead to coin prices appreciating. The results are extremely consistent for anti-money laundering and issuance regulation policies and rather consistent for exchange regulation and state-backed issuance. There is no evidence to suggest that the market is influenced either by the risk concerns of regulators or by government officials expressing their attitudes towards cryptocurrencies publicly.

The findings concerning market efficiency are mixed. There are slight inefficiencies in the form of underreaction regarding the treatment of anti-money laundering and exchange regulation news, relevant information being reflected in the market price only on the following day. However, it might alternatively imply relative complexity of information verification. For issuance regulation and state-backed issuance, the significant price change occurs on the event day only, largely reaffirming the weak efficient market hypothesis for the cryptocurrency market. Overall, the cryptocurrency market is shown to be more efficient in the treatment of technological factors such as 51% attacks (Shanaev et al., in press) rather than regulatory factors, explainable either by the higher uncertainty associated with the latter or, alternatively, by the specific expertise of cryptocurrency market participants. The study has not found any anticipation effects prior to the regulatory events, simultaneously supporting that they are highly unpredictable and evidencing that regulators and other potentially knowledgeable parties do not participate in insider trading prior to the announcements to profit from the private information they possess.

The findings of the study generally suggest that excessive regulation of cryptocurrencies is counterproductive, at least at the current stage of their development, and a hands-off, laissez-faire or a "sandbox" attitude can prove itself more appropriate. As such, government

commitments not to overregulate cryptocurrencies and to let the industry develop in a freer environment can contribute to lower market volatility and more stable coin and token prices.

This research also has significant implications for investors, as it shows the relevance of news analysis for the cryptocurrency markets, as traders can suffer significant losses if they do not account for regulatory events in their strategies. It has demonstrated that cryptocurrency price responses to these events are universal across all crypto-asset classes, implying that there is no "safe haven" from regulation on the cryptocurrency market, unlike in the case of macroeconomic (Corbet et al., 2017), macro-financial (Ciaian and Rajcaniova; 2018), and geopolitical (Aysan et al., 2019) factors.

The limitations of the study are mainly associated with a short sample period and homogeneous treatment of regulatory events from each of the five identified groups. However, as the sample included both bullish and bearish sub-periods and as the estimation results were highly significant and consistent, these limitations are not expected to materially affect the sign and magnitude of the findings. Future research might investigate the relationship between cryptocurrency regulation and coin prices in a more heterogeneous manner, accounting for different regulatory events (for example, events originating in a different jurisdiction) having varying impact on the market.

List of references

Atzori, M. (2015). *Blockchain technology and decentralized governance: is the state still necessary?* http://dx.doi.org/10.2139/ssrn.2709713

Auer, R., & Claessens, S. (2018). Regulating cryptocurrencies: assessing market reactions. *BIS Quarterly Review September.*

Aysan, A., Demir, E., Gozgor, G., & Lau, C. (2019). Effects of the geopolitical risks on Bitcoin returns and volatility. *Research in International Business and Finance, 47*(1), 511-518.

Baur, D., Hong, K., & Lee, A. (2018). Bitcoin: Medium of exchange or speculative assets? *Journal of International Financial Markets, Institutions and Money, 54*(1), 177-189.

Bech, M., & Garratt, R. (2017). Central bank cryptocurrencies. *BIS Quarterly Review September*.

Beer, C., & Weber, B. (2015). Bitcoin – the promise and limits of private innovation in monetary and payment systems. *Monetary Policy and the Economy, 11*(4), 53-66.

Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. *Journal of Economic Perspectives, 29*(2), 213-238.

Bollen, R. (2013). The legal status of online currencies: are Bitcoins the future? *Journal of Banking and Finance Law and Practice.*

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327.

Brandvold, M., Molnár, P., Vagstad, K., & Valstad, O. (2015). Price discovery on Bitcoin exchanges. *Journal of International Financial Markets, Institutions and Money, 36*(1), 18-35.

Brown, S., & Warner, J. (1985). Using daily stock returns: The case of event studies. *Journal of Financial Economics, 14*(1), 3-31.

Bryans, D. (2014). Bitcoin and money laundering: mining for an effective solution. *Indiana Law Journal, 89*(1), 441-472.

Campbell, K., Gordon, L, Loeb, M., & Zhou, L. (2003). The economic cost of publicly announced information security breaches: empirical evidence from the stock market. *Journal of Computer Security, 11*(3), 431-448.

Ciaian, P., & Rajcaniova, M. (2018). Virtual relationships: Short-and long-run evidence from BitCoin and altcoin markets. *Journal of International Financial Markets, Institutions and Money, 52*(1), 173-195.

Civitarese, J. (2018). *Technical Development, Asset Prices and Market Efficiency in Alternative Cryptocurrencies.* http://dx.doi.org/10.2139/ssrn.3154124

Corbet, S., Larkin, C., Lucey, B., Meegan, A., & Yarovaya, L. (2017). *Cryptocurrency reaction to FOMC announcements: Evidence of heterogeneity based on blockchain stack position.* http://dx.doi.org/10.2139/ssrn.3073727

Corbet, S., Meegan, A., Larkin, C., Lucey, B., & Yarovaya, L. (2018). Exploring the dynamic relationships between cryptocurrencies and other financial assets. *Economics Letters, 165*(4), 28-34.

Corbet, S., Lucey, B., Urquhart, A., & Yarovaya, L. (2019). Cryptocurrencies as a financial asset: A systematic analysis. *International Review of Financial Analysis, 62*(1), 182-199.

Costelloe, K. (2017, December). *Bitcoin 'ought to be outlawed,' Nobel prize winner Stiglitz says.* Retrieved from https://www.bloomberg.com.

Davidson, L., & Block, W. (2015). Bitcoin, the regression theorem, and the emergence of a new medium of exchange. *Quarterly Journal of Austrian Economics, 18*(3), 311-338.

Dwyer, G. (2015). The economics of Bitcoin and similar private digital currencies. *Journal of Financial Stability, 17*(2), 81-91.

Foley, S., Karlsen, J., & Putniņs, T. (2019). Sex, drugs, and bitcoin: How much illegal activity is financed through cryptocurrencies? *The Review of Financial Studies*, *32*(5), 1798-1853.

Fry, J. (2018). Booms, busts and heavy-tails: The story of Bitcoin and cryptocurrency markets? *Economics Letters*, *171*(4), 225-229.

Grinberg, R. (2011). Bitcoin: an innovative alternative digital currency. *Hastings Science & Technology Law Journal*, *4*(1), 160-208.

Hausman, J. (1978). Specification tests in econometrics. *Econometrica*, *46*(6), 1251-1271.

Hendrickson, J., & Luther, W. (2017). Banning bitcoin. *Journal of Economic Behavior & Organization*, *141*(3), 188-195.

Karamitsos, I., Papadaki, M., & Al Barghuthi, N. (2018). Design of the Blockchain smart contract: a use case for real estate. *Journal of Information Security*, *9*(3), 177-190.

Lee, D., Guo, L., & Wang, Y. (2018). Cryptocurrency: a new investment opportunity? *The Journal of Alternative Investments*, *20*(3), 16-40.

Liu, Y., & Tsyvinski, A. (2018). *Risks and returns of cryptocurrency* (No. w24877). National Bureau of Economic Research.

Liu, Y., Tsyvinski, A., & Wu, X. (2019). *Common risk factors in cryptocurrency* (No. w25882). National Bureau of Economic Research.

MacKinlay, A. (1997). Event studies in economics and finance. *Journal of Economic Literature*, *35*(1), 13-39.

Petersen, M. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies*, *22*(1), 435-480.

Shanaev, S., Shuraeva, A., Vasenin, M., & Kuznetsov, M. (in press). Cryptocurrency value and 51% attacks: evidence from event studies. *The Journal of Alternative Investments*.

Slattery, T. (2014). Taking a bit out of crime: Bitcoin and cross-border tax evasion. *Brooklyn Journal of International Law, 39*(2), 829-873.

Swan, M. (2015). *Blockchain: blueprint for a new economy.* O'Reilly Media, Inc.

Truby, J. (2018). Decarbonizing Bitcoin: law and policy choices for reducing the energy consumption of blockchain technologies and digital currencies. *Energy Research & Social Science, 44*(4), 399-410.

Wang, G., Xie, C., Wen, D., & Zhao, L. (in press). When Bitcoin meets economic policy uncertainty (EPU): Measuring risk spillover effect from EPU to Bitcoin. *Finance Research Letters.*

White, L. (2015). The merits and feasibility of returning to a commodity standard. *Journal of Financial Stability, 17*(2), 59-64.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association*, *57*(2), 348-368.