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Globalization Institute Working Paper 381 **April 2020**

Research Department

https://doi.org/10.24149/gwp381

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April 2020

Abstract

Cryptocurrencies are often thought to operate out of the reach of national regulation, but in fact their valuations, transaction volumes and user bases react substantially to news about regulatory actions. The impact depends on the specific regulatory category to which the news relates: events related to general bans on cryptocurrencies or to their treatment under securities law have the greatest adverse effect, followed by news on combating money laundering and the financing of terrorism, and on restricting the interoperability of cryptocurrencies with regulated markets. News pointing to the establishment of specific legal frameworks tailored to cryptocurrencies and initial coin offerings coincides with strong market gains. These results suggest that cryptocurrency markets rely on regulated financial institutions to operate and that these markets are segmented across jurisdictions.

JEL codes: E42, E51, F31, G12, G28, G32, G38.

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[*]This paper is a minor update of Auer and Claessens (2018). We thank Codruta Boar and Giulio Cornelli for outstanding research assistance and David Archer, Morten Bech, Claudio Borio, Benjamin Cohen, Jon Frost, Benoît Mojon and Hyun Song Shin for their comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS, the Federal Reserve Bank of Dallas or the Federal Reserve System.

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Cryptocurrencies[1] such as Bitcoin[2] or Ethereum have attracted much attention, because of both meteoric price swings and their advocates' claim of a new model of decentralised trust. Many are analysing the validity of such claims and the economics of the underlying technology (Auer (2019a), BIS (2018), Carstens (2018a,b,c), CPMI (2015)). Concurrently, many national authorities and international bodies have expressed concerns (eg G20 Finance Ministers and Central Bank Governors (2018), FSB (2018), Carney (2018)).

Many of the concerns raised would also apply to other asset classes and emergent technologies. But what sets cryptocurrencies apart is that they can function without institutional backing and are intrinsically borderless.[3] This raises the question of whether one can expect regulation – in particular national regulation – to be effective.

To shed light on this issue, we examine whether and how regulatory actions and communications about such actions have affected cryptocurrency markets (see also Auer and Claessens (2019)). We do so using an event study approach. A number of jurisdictions have announced that they are considering whether and how to respond, and some have already responded. We use the market reactions to these regulatory statements and decisions to assess the anticipated effects on cryptocurrency markets.

Our four main findings are as follows. First, the market responds most strongly to news events regarding the legal status of cryptocurrencies. Besides general bans on their use for financial transactions, news events related to their possible treatment under securities market law have strongly adverse impacts, as do events explicitly signalling that cryptocurrencies will not be treated as a currency. News indicating possible novel legal frameworks tailored to cryptocurrencies and initial coin offerings (ICOs) coincides with strong market gains. Second, regulatory news regarding anti-money laundering/combating the financing of terrorism (AML/CFT) measures and limits on the interoperability of cryptocurrencies with the regulated financial system adversely impacts cryptocurrency markets. Third, authorities' unspecific general warnings have no effect, nor does news regarding the likelihood of central bank digital currency (CBDC) issuance.[4] Last, large price differences sometimes prevail across jurisdictions, suggesting some market segmentation.

Overall, our analysis suggests that, at the current juncture, there is scope to apply regulations, if so decided. And it also indicates that regulation need not be bad news

[1] Terminology on this topic is fluid and evolving, with related legal and regulatory ambiguities. The use of the term "cryptocurrencies" is not meant to indicate any particular view of what the underlying protocol-based systems are; typically, they lack the key attributes of a sovereign currency and their legal treatment varies across jurisdictions. In some cases, the feature refers to specific cryptocurrencies or cryptoassets as examples. These examples are not exhaustive and do not constitute any endorsement by the authors, the BIS, of any cryptocurrency, firm, product or service.

[2] We distinguish between the protocol and network of users and miners of a cryptocurrency, and the unit of a cryptocurrency. For example, the unit of the Bitcoin cryptocurrency is bitcoin, while the unit of the Ethereum cryptocurrency is ether.

[3] Note that only those cryptocurrencies based on permissionless, decentralised protocols are open to anyone and thus entity-free. By contrast, cryptocurrencies running on permissioned protocols give select actors special access rights. Inasmuch as those select actors can be identified, such cryptocurrencies can be identified with legal entities. See BIS (2018) for a discussion of the differences between permissionless and permissioned cryptocurrencies.

[4] See Auer et al. (2020) for a stock take of reports and ongoing technological developments. Auer and Böhme (2020) examine the technical design of CBDC issued to the general population.

for the markets, with price responses notably signalling a clear preference for a defined legal status, albeit a light regulatory regime.

To tackle regulatory concerns, authorities will first need to clarify the regulatory classification of cryptocurrency-related activities, and to do so using criteria based on economic functions rather than the technology used. Related, the boundaries among national regulatory bodies may need to be redrawn to clarify responsibilities. Authorities will need to vigilantly monitor developments and address regulatory issues arising from the global dimension of cryptocurrencies. For policies to remain effective, and especially in case the market further develops and international arbitrage increases, rules and enforcement will need to be coordinated and enforced across the globe.

But the absence of such coordination need not be an impediment to effective intervention. One avenue authorities could pursue is "embedded supervision" (see Auer (2019b)), ie implement a supervisory framework for crypto assets that allows for compliance with regulatory goals to be automatically monitored by reading the market's ledger. The idea is to restore the level playing field when it comes to regulatory standards, while at the same time offering a technology-driven approach that can ease the administrative burden of supervision.

This paper is organised as follows. We first briefly review the current debate on why and how to regulate cryptocurrencies to help us classify news about (possible) policy interventions by category and regulatory stance. We then assess the effects of such news events on prices, trading volumes and other dimensions, including cross-border, based on a new data set of regulatory news events. Lastly we draw some lessons from our analysis.

An empirical investigation

Classifying news on cryptocurrency regulation

The goals of regulating cryptocurrencies are largely similar to those for other financial assets and services and can be classified into three categories: combating the use of funds for illicit activities;[5] protecting consumers and investors against fraud and other abuses; and ensuring the integrity of markets and payment systems and overall financial stability. Regulatory authorities have a number of tools at their disposal for addressing these goals.

First, to address illicit use, responses can be aimed at those firms providing access to cryptocurrencies. Most consumers and investors do not directly own or trade cryptocurrencies, but rather use crypto-wallets and other intermediaries that hold claims on their behalf. Many relevant regulations may already pertain to such crypto-infrastructure providers; similarly, existing rules and enforcement mechanisms can be adapted to address specific issues. For example, AML/CFT regulations already in place can often be extended to cryptocurrencies. And existing consumer and investor protection laws and regulations can often be applied or adapted.

[5] For examples highlighting the use of cryptocurrencies for illegal activities, see Fanusie and Robinson (2018) and Foley et al (2018).

Second, regulations can target the interoperability of cryptocurrencies with regulated financial entities, including commercial banks, credit card companies and exchanges. Such regulated entities enable individuals to convert sovereign currency to cryptocurrencies and back. Rules can also be developed and applied with regard to the admissibility of cryptocurrencies and related products (such as derivatives or exchange-traded funds (ETFs)) on regulated exchanges. And regulation can address whether and how banks are allowed to deal in cryptocurrency-related assets for their customers or on their own behalf, and, if trading is allowed, what the associated tax implications are.

Third, authorities can clarify the legal status of cryptocurrencies. This shapes issues such as consumer protection (eg how to treat ownership rights, theft and mis-selling) and retail use (eg who may legitimately trade cryptocurrencies and under what conditions). Another key legal status issue is whether cryptocurrencies are treated as securities – ie tradable instruments used to raise funds by representing a promise to pay in the future – and thus come under heightened regulation and oversight. Alternatively, they could be considered generic assets (ie tangible or intangible things that can be owned or controlled, eg houses, commodities, patents), which means they can be held and traded, including on organised exchanges, without necessarily having to satisfy strict securities market rules and face corresponding oversight.[6]

To analyse these issues, we draw on Auer and Claessens (2018), who assemble a data set of news events regarding policy statements made by regulatory bodies, central banks and relevant international institutions and standard-setting bodies related to cryptocurrencies markets over the past years. Regulatory news events are classified into one of the three above main categories. In addition to classifying by regulatory aspects, we also differentiate events by regulatory stance. For this we use a simple coding scheme, namely a binary variable taking a value of +1 for events associated with tougher or more sharply defined regulation and –1 for events pointing to less stringent or less defined regulation.[7]

Additionally, we also code two auxiliary categories: one for general information and warnings issued to the general public on cryptoassets, and one on authorities' statements on CBDCs.[8] We include all news events from the start of 2015 to the end of June 2018 as reported by the news agency Reuters, with the sample criterion being inclusion in this news channel.

[6] Here the novelty and complexity of the underlying technology, as well as its rapid evolution, can make it difficult to design and apply regulation and oversight. The main conundrum is that the same technology can be, and often is, used for a variety of economic purposes. For example, ICOs are being used by technology firms to raise funds for projects unrelated to cryptocurrencies. Other than semantics – auctioning coins instead of shares – ICOs are no different from initial public offerings, so it would be natural to apply similar regulation and supervision policies to them. But some ICOs also double as "utility tokens" that essentially promise future access to software such as games or music albums. This does not constitute investment activity and instead calls for the application of consumer protection laws by the relevant bodies.

[7] In making these assessments, we follow the news agency interpretation of the news events, and thus rely on the news agency to judge the importance of the news.

[8] Bech and Garratt (2017) and CPMI and MC (2018) provide introductions to and economic analyses of CBDCs.

In total we identify 151 regulatory news events.[9] Graph 1 gives a breakdown of events by country, type and score (left-hand panel), by country (centre panel), and over time (right-hand panel). The left-hand panel shows that, after general warnings, news events related to interoperability are the most common. The centre panel shows that most news events are in China, India, Japan, the United Kingdom and the United States. The right-hand panel shows that news events have increased over time.

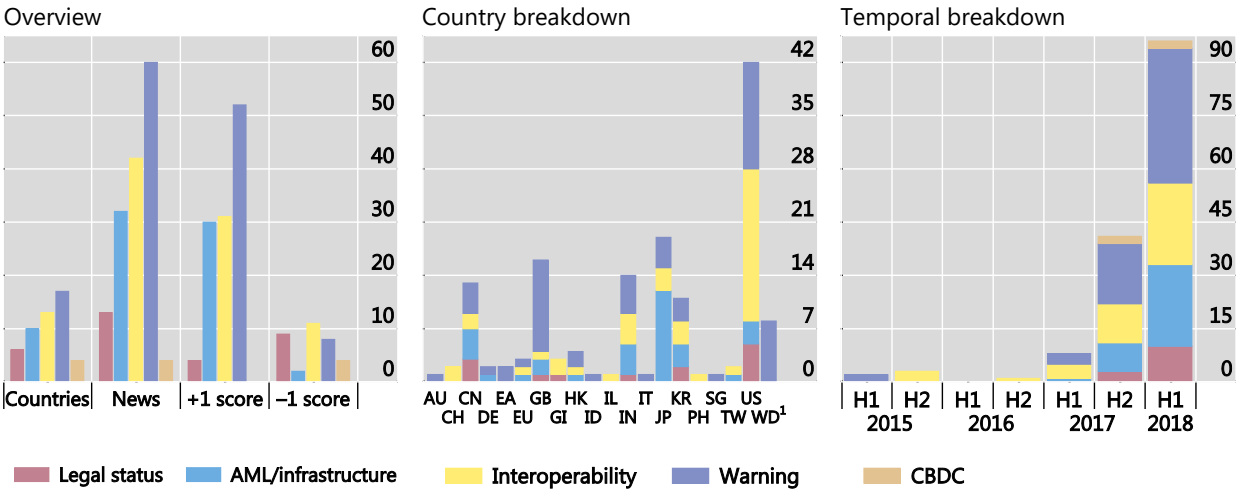
The price impact of regulatory news on bitcoin

We assess the intraday impact of regulatory news events first on the price of bitcoin, and then on the prices of other cryptocurrencies and on other aspects of the cryptocurrency markets. Prices are forward-looking and, using a standard event study methodology (Campbell et al (1996)), are often used to assess the eventual impact of corporate and public actions.

[9] Events relate to actions and statements made by authorities in and officials of Australia, China, Chinese Taipei, Gibraltar, Hong Kong SAR, India, Indonesia, Israel, Japan, Korea, the Philippines, Singapore, Switzerland, and the United States, as well as the European Union and its member states, and select international institutions, groupings and regulatory bodies (euro area institutions, BIS, IOSCO, FSB and G20).

A news database on cryptocurrency-related policies

Number of news headlines — Graph 1



Legal status = specific legal framework + currency – securities – ban: specific legal framework: +1 if handled under a specific legal framework different from the one for securities; currency: –1 if against classifying cryptocurrencies as currency; securities: +1 if in favour of classifying cryptocurrencies as securities and –1 if against classifying cryptocurrencies as securities; ban: +1 if a ban is called for, decided or implemented.

AML/infrastructure = AML/CFT + infrastructure regulation: AML/CFT: +1 if stricter regulation called for, decided or implemented; infrastructure regulation: +1 if stricter regulation on crypto-exchanges or wallet providers is called for, decided or implemented; –1 if less strict regulation called for, decided or implemented.

Interoperability = regulated institutions + taxation + ICO + listing application: regulated institutions: +1 if holding/trading restrictions on regulated institutions called for, decided or implemented; taxation: +1 if taxes called for, decided or implemented; –1 if taxes uncalled for or tax-exempt status is granted; ICO: +1 if sheds a bad light and –1 if sheds a good light; listing application: +1 if rejected; –1 if granted.

Warning: +1 if it raises the level of concern; –1 if it reduces or removes concern.

CBDC: –1 if it is against possible issuance of central bank digital currency (there are no cases of +1).

[1] WD = world (BIS, G20 and IOSCO).

Source: Auer and Claessens (2018).

To illustrate our methodology, consider two events. One is the decision by the United States Securities and Exchange Commission (SEC) in March 2017 to turn down a proposal to alter stock exchange rules so as to allow the creation of an ETF for bitcoin. In the five minutes around the announcement, the price of bitcoin dropped by 16% (Graph 2, left-hand panel).[10] However, we note that more general events that do not signal a specific regulatory action, but rather are indicative of the authorities' general stance to digital assets have a sizeable impact on crypto markets. A good example is Marc Zuckerberg's hearing on Facebook Libra in October 2019 at the US congress (right-hand panel).

Another event is the Japanese Financial Services Agency (FSA) ordering six cryptocurrency exchanges to improve their money laundering procedures (June 2018). Again, prices tanked – although it seems to have taken several hours, until the start of the US trading day, for this measure to have its full effect (right-hand panel).

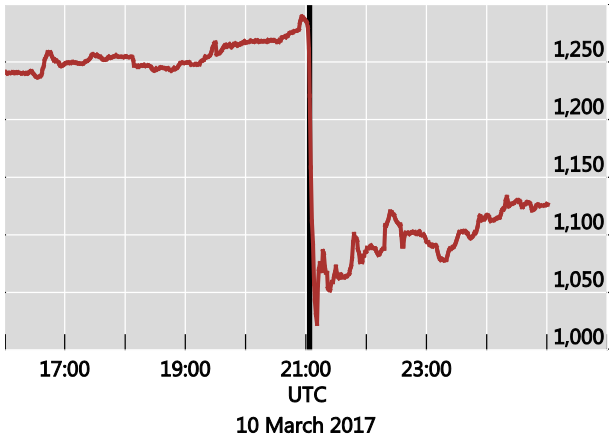
[10] Relatedly, the SEC's reconfirmation of the denial of a bitcoin ETF fund listing on 26 July 2018 sent the price of bitcoin tumbling from $8,220 to $7,920 (–3.7%) within a short period.

Bitcoin intraday price reaction to two news events

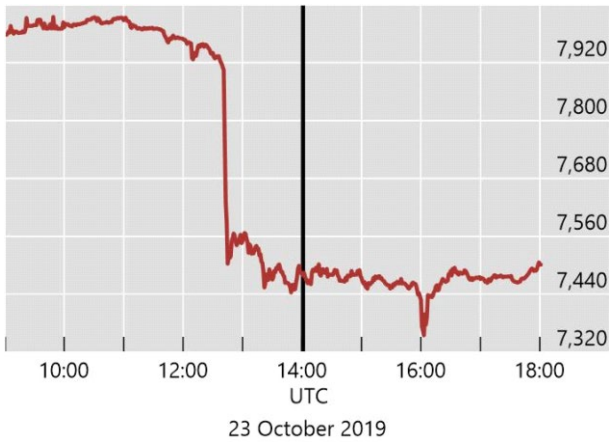
In US dollars

Graph 2

Listing application event[1]



Mark Zuckerberg's congressional testimony on Libra[2]



[1] The vertical line indicates 21:04 on 10 March 2017 (news headline: "US SEC rejects application to list Bitcoin ETF"). [2] The vertical line indicates 14:00 on 23 October 2019 (kick off time of Mark Zuckerberg testimony in front of Congress).

Source: Auer and Claessens (2018), Bloomberg; CoinDesk.

Using the same methodology, we can assess how prices on average adjust across news events (Graph 3), differentiating between favourable and unfavourable ones.[11] We find that favourable events coincide on average with a 0.33% return in the 120 minutes around the events (left-hand panel), and a 1.52% return in the 24-hour window around them (right-hand panel). Unfavourable events are associated with a 0.32% and 3.12% lower return over similar windows, respectively. Events appear to already affect prices several hours before the news release, suggesting the news is in fact released gradually and information flows via other channels.

We next examine price responses to the various types of news over a longer window, to accommodate such gradual release. We examine the 24-hour and 10-day price responses.

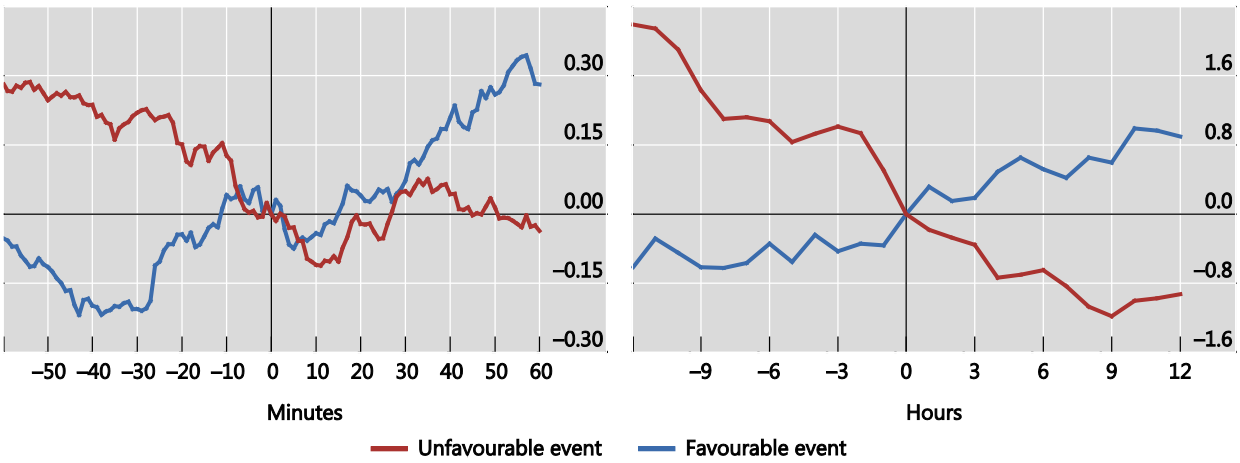
Graph 4 examines returns surrounding four specific categories of legal news. The price responses signal a clear market preference for a defined legal status, but under a light regulatory regime. News pointing to an outright ban and non-recognition of the instruments as currencies is associated with negative returns, and strongly so for bans. However, news suggesting that cryptocurrencies could be treated as securities

[11] We winsorised the price changes at the 5% and 95% level to avoid outliers that possibly reflect data limitations. We analyse general communications or statements on CBDC separately below.

News impact on intraday bitcoin price

In per cent

Graph 3



Average change in the bitcoin price relative to its price at the time of the news event. The data have been winsorised using the 5th and 95th percentiles as thresholds.

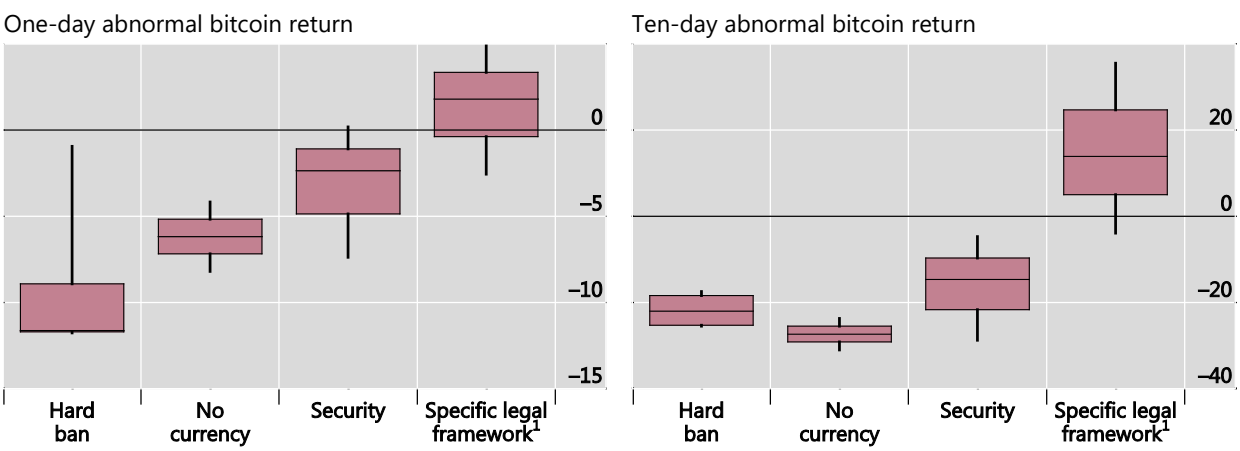
Sources: Auer and Claessens (2018); Thomson Reuters Eikon; CoinDesk; authors' calculations.

also leads to negative returns, probably reflecting the expectation that cryptocurrencies would be regulated more stringently. In contrast, the introduction of a specific, non-security legal framework generates positive returns, most likely as those frameworks generally come with oversight rules that are milder than those under securities law. The responses are qualitatively consistent between the one-day (left-hand panel) and the 10-day impact (right-hand panel), with the latter generally more pronounced.

Legal status news and bitcoin returns

In per cent

Graph 4



The box plots show minimum, lower quartile, median, upper quartile and maximum.

[1] Other than a security legal framework.

Sources: Auer and Claessens (2018); Thomson Reuters Eikon; CryptoCompare; authors' calculations.

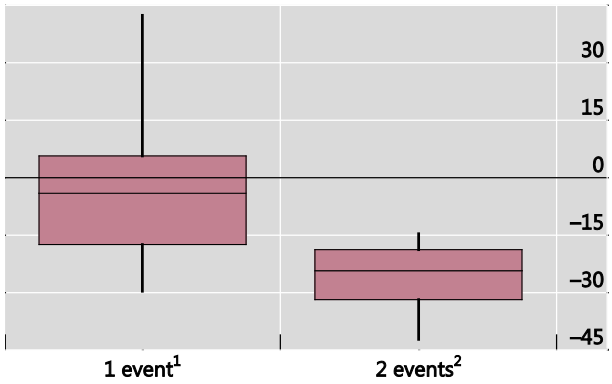
We next examine news regarding AML/CFT and cryptocurrency-related infrastructure regulations. We identified 32 such news events. An example of favourable news was in February 2018, when officials from the SEC and the Commodity Futures Trading Commission (CFTC) issued statements before the US Congress that news agencies interpreted as "putting crypto-currencies on a relatively long leash".[12] Examples of adverse news events were when the German Federal Financial Supervisory Authority (BaFin) issued an order in January 2018 to shut down a German-based crypto-exchange when on the same day the Japanese authorities announced mandatory IT security measures for crypto-exchanges.[13]

News indicating more restrictive AML standards for, and stricter regulation of, crypto-infrastructure providers is mostly associated with negative returns (Graph 5, left-hand panel). Such news led to negative returns over a 10-day window, with a median effect of around 4 percentage points, but with a wide distribution. For those days with more than one event, effects are much larger, some 24 percentage points.

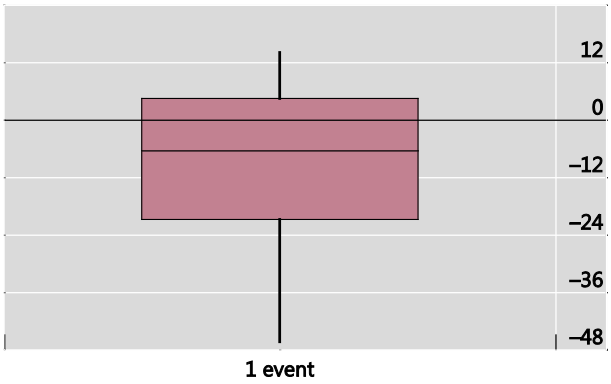
AML/infrastructure and interoperability news and bitcoin returns

In per cent — Graph 5

AML/infrastructure news and 10-day bitcoin abnormal returns



Interoperability news[3] and 10-day bitcoin abnormal returns[4]



The box plots show minimum, lower quartile, median, upper quartile and maximum.

[1] An event with an AML/infrastructure news score of –1 on 6 Feb 2018 (10-day bitcoin (BTC) return of 11.92%) is not included. [2] Refers to days on which two or more separate events occurred. [3] News in any one of the following categories: regulated institutions, ICO, listing application or taxation. [4] Does not include events with a interoperability news score of –1 on 16 Jul 2015 (10-day BTC return of –1.94%), 25 Jul 2016 (10-day BTC return of –26.8%), 27 Jan 2017 (10-day BTC return of 11.87%), 25 Apr 2017 (10-day BTC return of 14.91%), 24 Jul 2017 (10-day BTC return of –5.63%), 29 Sep 2017 (10-day BTC return of 2.75%), 24 Nov 2017 (10-day BTC return of 25.73%), 28 Nov 2017 (10-day BTC return of 36.48%), 14 Dec 2017 (10-day BTC return of –24.76%), 21 Mar 2018 (10-day BTC return of –21.77%) and 14 Jun 2018 (10-day BTC return of –10.45%).

Sources: Auer and Claessens (2018); Thomson Reuters Eikon; CryptoCompare; authors' calculations.

[12] The chairmen of the SEC and the CFTC testified before the US Senate Committee on Banking, Housing and Urban Affairs on 7 February 2018 (Clayton (2018) and Giancarlo (2018)). The news event as reported by Reuters was: "The watchdogs did not […] demand immediate and sweeping new powers. Instead, they acknowledged the potential benefits of digital coinage, including lower costs for businesses, and advocated a 'do no harm' approach to new rules" (Beddor (2018)).

[13] Since the data are collapsed to the daily frequency, there can be more than one news event on a day, and the resulting variable can thus take a negative or positive integer value greater than +1, or smaller than –1. There are 86 cases for which we use the overall daily news score.

Finally, we look at 42 news events related to interoperability with regulated markets and entities, of which four pertain to the interoperability of cryptocurrencies with banks, four to taxation, 20 to decisions on ICO applications and 14 decisions to listing applications for ETFs or derivatives. Interoperability is on average also associated with a decline, of some 6.4 percentage points (Graph 5, right-hand panel).

Regression analysis

We next investigate the price responses to regulatory news events using regressions, which allows us to examine statistical significance and the joint effects of news concerning various types of regulation. We estimate the following regressions in the 10-day window starting two days before the event and ending eight days after the event:

$$log\left(P_{BTC,t+8}/P_{BTC,t-2}\right) = \alpha + \beta R_t^{indicator} + \varepsilon_t$$

where in this specification *P* is again the price of bitcoin, R_t is the regulatory score for each news event in the specific category on date t (or 0 if there is no event). In the regressions we thus also include the days without regulatory news to control for the "normal" daily movements in prices (or other dependent variables).

As before, news events are "signed" to reflect their expected impact on cryptocurrency usage. Specifically, we code legal status news as:

$$R_t^{LegalStatus} = R_t^{Framework} + R_t^{Currency} - R_t^{Ban} - R_t^{Security}$$

ie $R_t^{LegalStatus}$ takes a value of +1 for a favourable news event, eg when a specific cryptocurrency framework is announced or news indicates that cryptocurrencies will not be considered to be a "security", and –1 whenever news indicates a ban, that cryptocurrencies are not considered as currencies, or that they will be considered securities. This coding scheme implies that positive values of $R_t^{LegalStatus}$ are favourable events for cryptocurrencies.

Considering news events in terms of the three categories, the results confirm that events in each category have an economic and statistically significant impact (Table 1, columns 1–3). There is little change in the magnitudes of coefficients when estimated jointly (column 4). Importantly, the regression results show that the economic impact is again the largest for news about the legal status of cryptocurrencies. News in the other two categories has a statistically significant, but smaller, impact in terms of average market response.

Warnings disseminated by government agencies have no statistically significant effect on valuations (column 5). And the positive, but not significant, coefficient for the news on the stance of senior officials regarding CBDC (column 6) suggests that CBDCs are not seen as relevant for privately issued cryptocurrencies.

The wider crypto-ecosystem responses to regulatory news

Next we show that news events also affect the prices of cryptocurrencies other than bitcoin, cryptocurrency transaction volumes, the number of addresses[14] (a gauge for

[14] The number of active addresses equals the number of unique cryptocurrency addresses that contain any funds. Though users typically own multiple addresses, unless regulation primarily affects the average number of addresses per user, the decline in the number of addresses also indicates a decrease in the number of active users.

The price impact of regulatory news: regression results Table 1

	Dependent variable: 10-day response of BTC/USD price					
	(1)	(2)	(3)	(4)	(5)	(6)
AML or crypto-exchange regulation	–7.680***			–6.082***		
	(2.070)			(2.074)		
Interoperability with banks or exchanges		–5.832***		–5.150***		
		(1.836)		(1.829)		
Legal status of cryptocurrencies			17.302***	16.448***		
			(3.499)	(3.489)		
General warnings					–1.147	
					(1.504)	
Authorities' views on CBDC						9.077
						(6.368)
Observations	1,272	1,272	1,272	1,272	1,272	1,272
R-squared	0.01	0.01	0.02	0.03	0	0

Standard errors in parentheses; ***/**/* denotes results significant at the 1/5/10% level.

Sources: Auer and Claessens (2018); Thomson Reuters Eikon; CryptoCompare; authors' calculations.

the underlying number of users) and the profitability of mining cryptocurrencies. Since this analysis spans seven cryptocurrencies and up to seven variables of interest, we reduce its dimensionality for conciseness. Specifically, we construct a global cryptocurrency regulatory news index (CRNI). Since we have already established which types of news matter for Bitcoin, we construct this index as a linear combination of the three sets of consequential regulatory news, with weights equal to the average news impact on bitcoin prices (regression coefficients from the joint model in column 4 of Table 1):

$$CRNI_t = -16.448\, S_t^{Legal} + 5.150\, S_t^{Interoperability} + 6.082\, S_t^{AML/Inf}$$

This index captures how, on a given day, regulatory events would have moved the price of bitcoin. We then gauge the price responses of other cryptocurrencies to changes in this index, ie we essentially see whether the prices of these other cryptocurrencies reacted more or less strongly to regulatory news than bitcoin did, on average. Regression results for a range of prices are presented in Table 2, panel A. In column 1 the dependent variable is the change in the price of bitcoin, which shows by construction an elasticity of one.[15] In columns 2–7, the dependent variable is the change in the price of ether (based on the Ethereum protocol), Bitcoin Cash, Litecoin, Monero, Zcash, and XRP (based on Ripple), respectively.

[15] Most news events (both favourable and unfavourable) took place since end-2017, a period when the price of cryptocurrencies has been in decline. But the downward trend (at –0.31% per day during the first seven months of 2018, or roughly –0.026% in a 120-minute window) is an order of magnitude too small to explain the patterns. To nevertheless investigate whether this trend affects our results, we re-estimated the specification for either all days in 2017 or only the first six months of 2018. Results are very similar to and statistically insignificant from –1 (–0.93 or –0.85, respectively), showing that on event days, price movements deviated significantly from the general pattern.

Response of prices and network volumes across cryptocurrencies Table 2

Cryptocurrency (unit)	Bitcoin	Ethereum (ether)	Bitcoin Cash	Litecoin	Monero	Zcash	Ripple (XRP)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A: 10-day percentage change in cryptocurrency price (in US dollars)						
Change in CRNI	–1.000***	–0.927***	–1.164**	–0.823***	–1.162***	–0.726**	–0.708**
	(0.151)	(0.309)	(0.466)	(0.243)	(0.284)	(0.337)	(0.338)
	Panel B: 30-day percentage change in transaction numbers						
Change in CRNI	–1.289***	–1.171***	–0.282	–2.073***			–0.253
	(0.156)	(0.281)	(0.541)	(0.449)			(0.330)
	Panel C: 30-day percentage change in transaction volume (in US dollars)						
Change in CRNI	–1.343***	–3.368***	–1.738***	–1.516**			
	(0.427)	(1.052)	(0.647)	(0.695)			
	Panel D: 30-day percentage change in active addresses						
Change in CRNI	–1.161***	–1.495***	–0.224	–1.431***			
	(0.140)	(0.351)	(0.703)	(0.303)			
	Panel E: 30-day percentage change in mining profitability						
Change in CRNI	–2.491***	–1.520***	–1.317***	–1.849***			
	(0.330)	(0.524)	(0.450)	(0.394)			
Observations (Panel A)	1,272	1,219	327	1,264	1,264	589	1,252

Standard errors in parentheses; ***/**/* denotes results significant at the 1/5/10% level.

Sources: Auer and Claessens (2018); Thomson Reuters Eikon; www.bitinfocharts.com; authors' calculations.

In terms of the responsiveness of cryptocurrencies compared with that of bitcoin,[16] we find that both "Bitcoin clones" – Bitcoin Cash and Litecoin – as well as the second largest cryptocurrency by valuation, Ethereum, react significantly to CRNI (columns 2–4). The impact is not significantly different from 1, however, ie they are as strongly affected by these news events as bitcoin is. We next examine so-called "dark coins" Monero and Zcash – that add an extra layer of anonymity. Monero reacts significantly and more strongly than bitcoin (column 5), while Zcash (for which we only observe less than two years of data given its shorter life span) reacts less (column 6). The XRP token also react less, which may reflect that its network of trusted nodes is centrally controlled by its issuer Ripple, making the XRP token distinct from other, permissionless, cryptocurrencies.

[16] Other coefficients have the interpretation of reacting in the same (opposite) direction and more (less) strongly than bitcoin does, depending on the coefficients being greater (smaller) than +1 (–1).

The remainder of Table 2 shows that regulatory news also affects the number and the volume of transactions, the number of active addresses, and the profitability of mining. These statistics are only available for Ethereum and non-anonymous Bitcoin offshoots (Table 2, panels B–E). In these regressions, the dependent variable is a slower-moving, aggregate volume rather than a forward-looking price, so we expand the time window, defining the dependent variable as the percentage change of each aggregate from the 30 days preceding the event to the 30 days thereafter.

Bitcoin, Litecoin and Ethereum react strongly to news events as captured by the coefficient of CRNI for the number and the volume of transactions (in US dollars). The number of active addresses also responds strongly to CRNI, which may indicate that stronger regulation results in a decline in the number of users. The evidence for Bitcoin Cash is somewhat mixed: the number of transactions reacts little, while the average transaction volume reacts strongly, implying an increase in the average transaction size.

Finally, miners, ie those engaged in verifying transactions, are also affected by news events. In order to gauge this, we analyse a measure of profitability calculated as the revenue from block rewards and transaction fees minus the estimated cost of coming up with a proof-of-work. For all four cryptocurrencies with detailed data available, profitability declines strongly whenever regulation becomes tighter. Since profitability is likely to affect exit and entry of miners, this response ultimately can also affect the security of the various cryptocurrencies.

National regulation of global cryptocurrencies

Why do news events about national regulations have such a substantial impact on cryptoassets that have no formal legal homes and are traded internationally? Part of our interpretation is that cryptocurrencies rely on regulated institutions to convert regular currency into cryptocurrencies. Their cumbersome setup also means that many consumers hold and transact in cryptocurrencies through more interfaces, such as online crypto-wallets that are often regulated, or can be regulated in principle. And international arbitrage is still limited. Agents cannot easily access cryptocurrencies' markets offshore – because they may need to have a bank account in the foreign jurisdiction. Factors such as these create market segmentation and fragmentation, which currently make national regulatory actions bind to some degree.[17]

One example of likely market segmentation is the so-called "kimchi premium", the fact that the price of bitcoin in Korea regularly exceeds that in the United States, at times by over 50% (Graph 6, left-hand panel). This suggests limits to cross-border arbitrage. Similarly, news about cryptocurrency regulation by authorities in China has led at times to price differentials compared with the US market (Graph 6, centre panel).

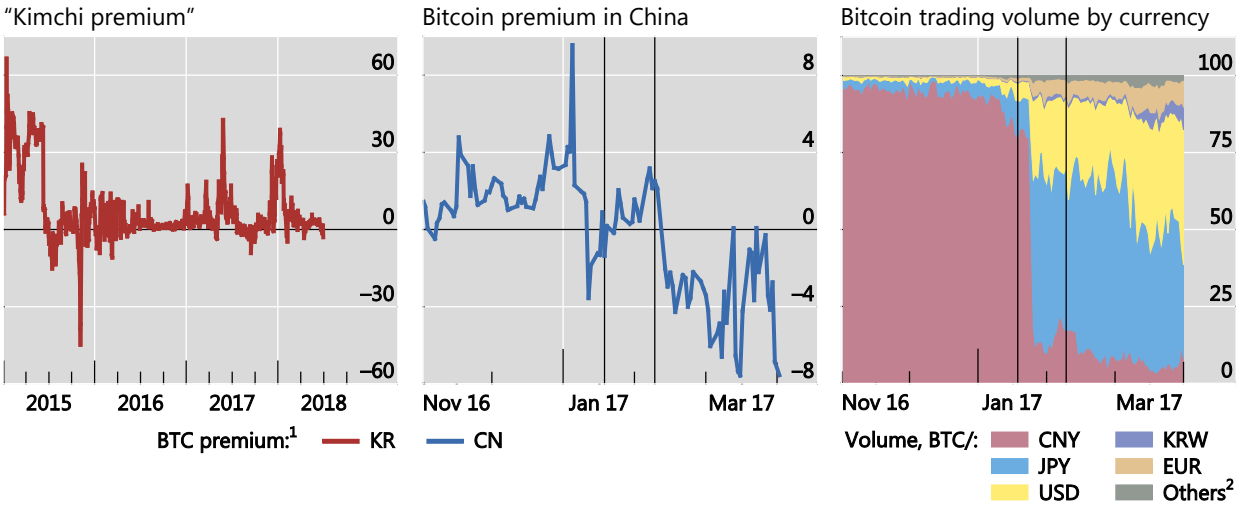
Yet national regulatory measures do spill across borders. For example, when China hinted at the possibility of strict regulation of Bitcoin around the end of January 2017, bitcoin trading shifted massively towards other Asian currencies (Graph 6, right-hand panel).

[17] Another channel would be the reputation effect: the possibility that a decision by one government could encourage other governments to adopt an "anti-crypto" mindset.

Premia and trading volume

In per cent

Graph 6



The vertical lines in the centre and right-hand panels indicate 19 January 2017 ("MEDIA-PBOC branch finds 'hidden risks' in bitcoin exchange BTCC-EID") and 9 February 2017 ("China central bank says warned bitcoin exchanges of closure risk on rule violations").

[1] Premium of local BTC price (in USD) compared with BTC price in the United States. [2] AUD, CHF, CAD, GBP, HKD, ILS, INR, PHP and SGD.

Sources: Auer and Claessens (2018), CryptoCompare.com; authors' calculations.

Conclusion

Our analysis shows that despite the entity-free and borderless nature of cryptocurrencies, regulatory actions, as well as, news regarding potential regulatory actions can have a strong impact on cryptocurrency markets, at least in terms of valuations and transaction volumes. This suggests that at the current juncture, authorities around the globe do have some scope to make regulation effective.

Looking ahead, there are three challenges.

First, to effectively address regulatory concerns and achieve technology-neutral regulation, authorities will need to clarify cryptocurrency-related activities from legal and securities market perspectives, and to do so according to economic purpose rather than technology used. Related, the boundaries among national regulatory bodies may need to be redrawn to clarify responsibilities.

Second, although markets are currently somewhat segmented, cross-border spillovers can occur in response to regulatory events. As the market continues to evolve, and if more banks and funds engage in cross-country arbitrage, regulation and enforcement in one jurisdiction may lead activity to migrate to others with more lax approaches. Coordination has already been found to enhance the effectiveness of AML standards, with authorities seeking to treat similar products and services consistently according to their function and risk profile across jurisdictions (eg Financial Action Task Force (2015)). To maximise impact and avoid leakages, internationally consistent approaches should be used for cryptocurrencies as well.

Third, while we did not analyse this in the current study, a number of observers have concluded that at the current stage of market development, cryptocurrencies do

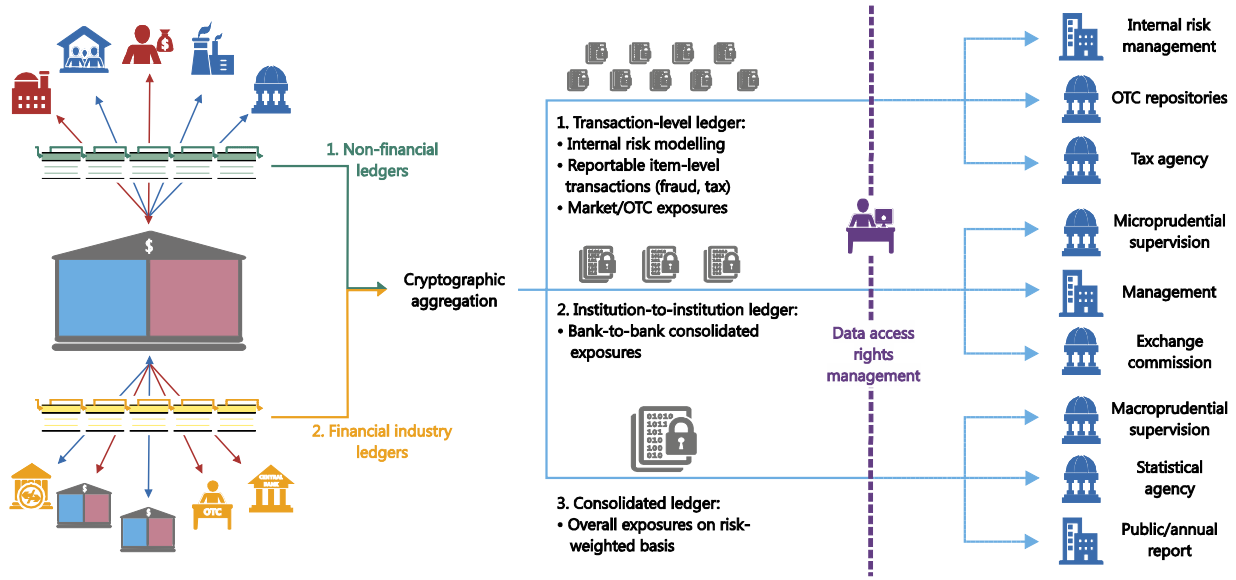
not appear to present macroeconomic or financial stability issues (Carney (2018), FSB (2018)). And while illicit uses of course transcend borders, it seems hard to use cryptocurrencies to circumvent capital controls on a large scale. That said, new types of crypto-products, such as crypto-funds and derivatives on cryptocurrencies and cryptoassets, create additional linkages with the financial system. And cryptocurrencies and other cryptoassets can piggyback on the conventional financial system. A loss of public trust in cryptoasset markets could translate into distrust in the broader financial system and its regulators. While cryptoassets thus do not, at this point, pose a global financial stability risk, it is important to remain vigilant, monitor developments and respond to potential threats.

Looking ahead, authorities that are open to allow for cryptocurrencies, but do not want them to undermine existing regulatory standards could pursue the approach of "embedded supervision" proposed in Auer (2019b). Embedding supervision means that compliance with regulatory goals is automatically monitored by reading the market's ledger (se Graph 7). This means to verify compliance with regulations by reading the distributed ledgers of cryptocurrencies. Supervisors could access all transaction-level data that is publicly available.

The idea would be to restore the level playing field when it comes to regulatory standards, while at the same time offering a technology driven supervisory approach that eases the administrative burden.

Compliance process using embedded supervision

Graph 7



Embedded supervision can verify compliance with regulations by reading the distributed ledgers in both wholesale (symbolised by the green blockchain) and retail banking markets (symbolised by the yellow blockchain). Supervisors could access all transaction-level data. Alternatively, the use of smart contracts, Merkle trees, homomorphic encryption and other cryptographic tools might give supervisors verifiable access just to selected parts of such micro data, or relevant consolidated positions such as to institution-to-institution or sectoral exposures. Firms would only need to define the relevant access rights, obviating the need for them to collect, compile and deliver data.

Source: Auer, R (2019b) "Embedded supervision: how to build regulation into blockchain finance" BIS Working Papers No. 811, September

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