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Working Paper Crypto news and policy innovations: Are European markets affected?

JRC Working Papers in Economics and Finance, No. 2024/7

Provided in Cooperation with: Joint Research Centre (JRC), European Commission

Suggested Citation: Barbaglia, Luca; Bellia, Mario; Di Girolamo, Erica Francesca; Rho, Caterina (2024) : Crypto news and policy innovations: Are European markets affected?, JRC Working Papers in Economics and Finance, No. 2024/7, European Commission, Ispra

This Version is available at: https://hdl.handle.net/10419/311092

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EU Science Hub https://joint-research-centre.ec.europa.eu

JRC138863

Ispra: European Commission, 2024

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How to cite this report: European Commission, Joint Research Centre, Barbaglia, L., Bellia, M., Di Girolamo, F. and Rho, C., *Crypto news and policy innovations: Are European markets affected?*, European Commission, Ispra, 2024, JRC138863.

Crypto news and policy innovations: Are European markets affected?

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Abstract

Digital and crypto currencies are becoming an integral part of financial markets. Nevertheless, regulation of these markets seems still at an early stage and the literature evaluating the impact of policy interventions is scarce. We investigate the reaction of crypto markets in the aftermath of a policy announcement using textual information from news and sentiment analysis. Our findings are threefold. First, there is evidence of peaks in news about crypto-assets in correspondence of the date of new developments in EU legislation, in particular about Central Bank Digital Currencies. Second, we find that both returns of cryptocurrencies and general stock market returns are directly proportional to the news sentiment about crypto markets. Third, our event study shows that the introduction of regulation on digital and crypto currencies is perceived as a negative shock by financial markets, especially for digital currencies.

Keywords: cryptocurrencies, digital finance, text mining. *JEL codes*: C55, E42 G41

The views expressed are purely those of the authors and should not, in any circumstances, be regarded as stating an official position of the European Commission.

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1 Introduction

Digital finance is rapidly increasing, as technology continues to advance. Bitcoin, as a peer-to-peer electronic cash system, was proposed back in 2008 by Nakamoto (2008) and now digital currencies and cryptocurrencies are no longer a novelty in the financial world. A cryptocurrency is defined as "a digital currency produced by a public network, rather than any government, that uses cryptography to make sure payments are sent and received safely" (McIntosh, 2013). Other than as a digital mean of exchange, they may be used as investment assets, notwithstanding their high price volatility. To lower this risk, an alternative to cryptocurrencies are stablecoins. Stablecoins are cryptocurrencies where the value of the digital asset is supposed to be pegged to a reference asset, such as a fiat currency (usually USD), commodities (such as gold) or other cryptocurrencies. The convenience and accessibility of digital financial services have revolutionized the way individuals and businesses manage their finances. However, as the demand for digital finance grows, so does the need for regulation. The European Commission (EC) has made various proposals to address the evolving landscape of digital finance. However, such landscape is constantly reshaped by the rapid rollout of innovative technologies and investment tools, and it is important to closely monitor and understand these developments in order to properly shape the future of finance.

Notably, the EC adopted a digital finance package in 2020, including a Digital Finance Strategy that provided general guidelines on how support the digital transformation of the financial system. This package includes three main proposals. The first one seeks to ensure that all firms and financial institutions have adequate measures in place to mitigate cyberrisks, recognizing the growing dependency on digital ICT technologies (Digital Operational Resilience Act, DoRA). The second proposal is an initiative for a retail payments strategy, aimed to further develop the European payments market so that Europe can benefit fully from innovation and the opportunities that come with digitalisation. It is based on the principle that financial services customers own and control the data they supply and the data created on their behalf. The third one is the introduction of a framework for crypto-assets to draw on the possibilities offered by this market while mitigating the risks for investors and financial stability (Markets in Crypto-Assets Regulation, MiCA), establishing standardized rules for crypto-assets. As a results of the subsequent legislative process, DORA was officially signed in December 2022 and MiCA came into force in June 2023 together with a proposal for an Open Finance regulation.

The retail payment strategy of the EC is complementary to the potential introduction of a retail digital euro. In June 2023 the EC introduced the 'Single Currency Package' to support the use of cash and to propose a framework for a digital euro. The development of digital currencies issued by central banks (Central Bank Digital Currencies, or CBDC) would ensure that public money aligns with the preferences and needs of citizens and businesses. This is crucial in an era where electronic payments are increasing and cash alone is no longer sufficient to meet the needs of a digital economy (Allen et al., 2020). As a matter of fact, cryptocurrencies are nowadays utilized by both retail and institutional investors¹ and their interconnectedness with traditional finance has raised concerns about potential new risks (OECD, 2022). For example, Wu and Leung (2023) show that stablecoins such as Tether can amplify the volatility spillover from crypto assets to money market instruments, thus highlighting the need for improved disclosure practices on cryptocurrency and liquidity management for stablecoins. The Financial Stability Board (Financial Stability Board, 2022) and the OECD (OECD, 2022) have also raised concerns about the volatility spillovers from cryptocurrencies to traditional financial assets via reserve adjustments. Additionally, the recent work by Almeida and Gonçalves (2023) reviews investor behavior in the cryptocurrency market. Their findings suggest that social media and investors' sentiment heavily influence crypto markets, indicating how these markets are dominated by irrational investors who base their investment decisions on market sentiment. Investors' sentiment is a well-known indicator of financial market risk, applicable to both digital assets and traditional financial instruments (Renault, 2017; Fernandez et al., 2021).

Against this background, we aim to understand to what extent digital finance, particularly digital currencies, is covered and discussed in the news across EU countries. As previous research suggests that news and its sentiment can predict stock prices and macroeconomic

¹We refer to Halaburda et al. (2020) for a survey about the microeconomics of cryptocurrencies, elucidating what drives their supply, demand, trading price, and competition amongst them.

trends (e.g., Shapiro et al., 2022; Barbaglia et al., 2023). we investigate how this news affects the associated markets.

We contribute to the developing literature that studies the linkages between news sentiment and cryptocurrencies. Rognone et al. (2020) investigate the impact of news sentiment on Bitcoin and traditional currency returns on the Forex market, using high/frequency data. They find that Bitcoin experiences positive returns, either with positive and negative news sentiment. Our paper differs from this approach because it focuses specifically on sentiment about EU policy news, not on general news. Corbet et al. (2020) also analyze the response of digital assets to policy news, but they focus on monetary policy shocks, instead of legislative changes on cryptocurrency regulation. Interestingly, they find that digital currencies react in an heterogeneous way to Federal Open Market Committee announcements: currency-based digital assets, like Bitcoin, remain linked to the fiat currency market and react similarly to monetary policy announcements, while other digital assets sometimes move in the opposite direction. These findings may be in line with framing an ad-hoc regulation with respect to different kind of digital assets. Considering text-analysis models and dictionaries used in these studies, several metrics have already been developed applying the dictionaries that we also test in this paper. Ahn and Kim (2021) build a sentiment index to analyze the role of investors' emotions on Bitcoin trading volume and returns by extracting emotional factors in text published on a specialized blog where users discuss cryptocurrency trading. They find that Bitcoin return volatility and trading volume are significantly associated with their emotions index. Walker (2024) applies the Loughran and McDonald (2011) dictionary to analyze the sentiment in the newspaper narratives about Bitcoins. They find that news coverage that associate bitcoins with the topic of criminality, even though a negative topic, is associated with higher returns. Osman et al. (2024) build an Economic Sentiment Index based on Shapiro et al. (2022), showing that such index is able to predict stablecoins (like Tether) returns better than traditional or crypto returns.

This paper develops in four steps. First, we track the development of news on cryptocurrencies, such as Bitcoins, in EU countries over time. Second, we analyze whether there are abnormal peaks in news when new EU legislation or proposals are introduced. Third, we apply a sentiment analysis model to verify if news are positive or negative. Finally, an econometric approach is used to determine if news influence the price of cryptocurrencies or other financial indices in the EU stock markets. Our goal is to understand the complex interplay among media coverage, legislative developments, market sentiment, and financial market dynamics in EU, as digital finance continues to grow.

The remainder of the paper is structured as follows. Section 2 presents the data, while Section 3 explores the coverage in the news of policy intervention in digital markets. The usefulness of news sentiment in relation to stock markets is explored in Sections 4 and 5. Finally, Section 6 concludes.

2 Data

2.1 Keywords extraction

In order to select the most relevant keywords for our analysis, we use the Semantic Text Analysis (SeTA) system of the EC Joint Research Centre. SeTA is an innovative tool, developed by Hrade et al. (2019), which applies advanced text analysis techniques on extensive document collections to help with the understanding of concepts and to visualize the relationships and evolution of these concepts over time. SeTA has been specifically designed to support policymakers and researchers in their analysis of applied policy case studies.

By relying on SeTA, we confidently ensure that the keywords selected are relevant for the policy and public debate. This is crucial for our goal of analyzing the interconnections between news about crypto in EU countries and the associated policy developments. Indeed, the main corpus of SeTA consists of more than 500,000 policy-related documents published and managed by the EU Publication Office, all of which are written in English.² SeTA is able to identify terms similar to a given keyword, based on their typical usage in EU policy-related documents. Using this feature, we generate two word clusters, namely "cryptocurrencies" and "bitcoin", resulting in a list of 59 uni-grams and bi-grams listed in Table 1.³ Among these,

²Among others, the SeTA corpus includes the legal documents collected in EUR-Lex, reports, studies and other publications in the EU Publication website, the list of the projects funded by the EU's framework programmes for research and innovation included in CORDIS, and the databases of the EU Data Portal. For further information on these sources and the auxiliary documents repository, see Hrade et al. (2019).

 $^{^{3}}$ We check for variations in the keywords reported in Table 1 by lower-casing and controlling for singular and plural forms. On the other hand, we do not account for alternative spelling of the keywords other than

22 are specific to "crypto", 7 to "bitcoin", and 30 are common to both topics.⁴

Cryptocurrency	Common keywords	Bitcoin
bitcoin	bitcoins	card fraud
bitcoin blockchain	blockchain	cryptocurrency
cloud computing	blockchain technology	ecb virtual currency schemes
cloud services	blockchains	payment systems
credit card payments	cash	retail payment systems
crowdsourcing	cloud environment	smart contract
digital technology	credit card	virtual currency schemes
electronic payments	cryptocurrencies	
home banking	cryptomarkets	
internet technology	darknet	
internet-based	darknet markets	
ledger	digital currencies	
messaging	digital currency	
micropayment	distributed ledger	
micropayments	distributed ledgers	
mobile banking	electronic invoices	
new digital technologies	ethereum	
p2p	litecoin	
peer-peer	marketplaces	
social media	mobile payments	
social networking	online marketplaces	
social networks	open source software	
	payment cards	
	paypal	
	peercoin	
	prepaid cards	
	smart contracts	
	tokens	
	virtual currencies	
	virtual currency	

Table 1: Keywords for each topic of interest. Number of terms: 22 (cryptocurrency), 30 (common keywords), 7 (bitcoin).

Once we have selected the relevant keywords for each topic of interest, we also compile a list of tokens that refer to each of the EU27 countries (see Table A.1 in the Appendix). As a general criterion, we include the name of the country, the name of its capital in English, and

the ones reported by SeTA.

⁴The Bitcoin was the first cryptocurrency to significantly develop on financial markets and already overcome several individual boom and bust cycles. For this reason we add this more specific keyword to the general one of "cryptocurrencies".

the adjective referred to the country. In specific cases, we add the names of other important cities or regions within the country. For instance, for Italy, we include as cities Rome (the capital) and Milan (the main financial centre). Following the same criteria, for Spain we include Madrid, Catalonia and Barcelona. In the special case of Belgium, we also add the terms "European capital" and "EU capital" in reference to Brussels and its importance in EU policy.

2.2 News extraction

The analysis relies on Reuters News articles obtained from Dow Jones Factiva. The dataset comprises full-text articles (title and body) published from January 2000 to December 2023, consisting of 2.1 million articles and 640.5 million words. We search for texts that mention keywords from our compiled list, and are so related to the topics of "cryptocurrency" and/or "bitcoin". Additionally, we retain only articles that directly refer to at least one of the EU27 countries or the EU as a whole (see country-specific keywords in Table A.1).

Table 2 presents three representative cases encountered in our dataset. The column *article* displays the identifier number of the article, which contains one of the keywords of interest. The second column shows the keyword (in this example, "bitcoin"). The column *mentions* lists the number of occurrences of that specific word in the article along with the *country*. The fourth column lists each EU27 country mentioned in the article. The last column reports the date of publication of each article. In particular, Article 1 mentions 4 times the word "bitcoin", but only in reference to one EU country, Belgium. Article 2 mentions the word "bitcoin" only once, but in connection with four countries: France, Germany, Finland and Sweden. By construction, we count this word four times. The last article mentions the word "bitcoin" twice, along with multiple countries. Also in this case, the word is repeated in the database but with a higher frequency weight (2 versus 1 in Article 2). In addition to extracting news filtering by our specific keywords, we also aggregate them by day and country mentioned in the article.

article	keyword	mentions	country	date
1	bitcoin	4	BE	6-Jan-2014
2	bitcoin	1	\mathbf{FR}	18-Mar-2014
2	bitcoin	1	DE	18-Mar-2014
2	bitcoin	1	\mathbf{FI}	18-Mar-2014
2	bitcoin	1	SE	18-Mar-2014
3	bitcoin	2	FR	11-Sep-2014
3	bitcoin	2	NL	11-Sep-2014
3	bitcoin	2	IT	11-Sep-2014

Table 2: Example from our database

2.3 Policy relevant timeline

In this section, we select significant dates for EU policy actions by considering the implementation of recent EU legislation on cryptocurrencies and digital finance. These policy events are identified based on the policy timelines listed on the EC and European Council websites dedicated to the Digital Transition.⁵ We focus mainly on relevant discussions, provisional agreements and concrete EC proposals, as well as the publication of the related legislation. As an example, we include also the first sanction against cyber-attacks, imposed by the EU on July 2020.⁶

We focus on 30 policy events (the detailed list is in Table C.1 of the Appendix), that we categorize under three macro groups: (i) Central Bank Digital Currencies (CBDC); (ii) the Digital Finance Package proposed by the EC (DFP); and (iii) cybersecurity regulatory framework (Cyber). We cover events related to the Digital Euro and the CBDC for two main reasons. On the one hand, the introduction of a CBDC could raise concerns among cryptocurrency users, who may worry about potential limitations on innovation and competition in the cryptocurrency realm, as well as the potential decrease in the attractiveness of non-sovereign and decentralized cryptocurrencies. On the other hand, traditional investors might positively value the introduction of a CBDC, as it could serve as an effective compet-

⁵See: Council of the European Union timeline; European Commission timeline.

 $^{^{6}}$ See "The Council today decided to impose restrictive measures against six individuals and three entities responsible for or involved in various cyber-attacks."

itor to the growing influence of cryptocurrencies. In relation to the other two macro groups, stock markets might view the implementation of more stringent rules, on crypto or cyber risk, in a positive light. A well-designed regulation has in fact the potential to mitigate the risk associated with investing in this market, by eliminating potential malicious actors. This could pave the way for the development of new financial products and services, ultimately benefiting both the financial industry and the broader economy.

Overall, the majority of the events are related to the Digital Finance Package, as detailed in Table 3. This group includes several sub-packages: The Digital Market Act (DMA), The Digital Service Act (DSA), the Markets in Crypto-Assets Regulation (MiCA), the Digital Operational Resilience Act (DORA), and other events related to blockchain and Distributed Ledger Technology (DLT). Taken together, these regulations provide a more stringent framework for decentralized exchanges and crypto assets trades.

Table 3: Event groups

Group	Number of events	Period considered
CBDC	7	November 2020 - October 2023
Digital Finance Package	20	December 2020 - June 2023
Cybersecurity	3	July 2020 - October 2021

2.4 Stock market prices and cryptocurrencies data

To understand how policy discussions or events may influence cryptocurrency prices and financial market dynamics, we build a database of stock market indices and cryptocurrency indicators. Among stock market indices, we consider the 20 country benchmark stock market indices on EU markets.⁷ Eurostoxx 50 is used as a benchmark for the market model. All indices are taken from Bloomberg.

We download trading volumes and prices of cryptocurrencies from Coingecko, using the

⁷ATX (Austria), BEL20 (Belgium), PX (Czech Republic), OMXC25 (Denmark), OMX Tallin (Estonia), OMX Helsinki 25 (Finland), CAC40 (France), DAX (Germany), Athens Stock Exchange (Greece), Budapest SE (Hungary), ISEQ (Ireland), FTSE MIB (Italy), OMX Riga (Latvia), AEX (Netherlands), WIG20 (Poland), PSI20 (Portugal), IBEX35 (Spain), OMXS30 (Sweden), EUROSTOXX50 (EU as a whole).

dedicated API.⁸ In particular, we chose to extract the 10 most traded cryptocurrencies: Bitcoin, Ethereum, Tether, Binancecoin, Ripple, Solana, USD-coin, Staked-Ether, Cardano, and Dogecoin. Among them, Tether and USDcoin are stablecoins.⁹ In this case, we use as a benchmark the BGCI Bloomberg Galaxy Crypto Index (BGCI), designed to measure the performance of the largest cryptocurrencies traded in US dollars. Descriptive statistics of the data used in the analysis are presented in Table B.1 in the Appendix.

3 News coverage of EU legislation

In this section, we investigate the presence of abnormal peaks in news on specific dates to assess how policy events impact the frequency of our keywords. The keywords we have selected to isolate our topics of interest are not frequently found in newspapers, despite the increasing attention these topics have received in the last years. For this reason, we use a Poisson model in a panel setting, as this model is well-suited for our data: the number of mentions is a count variable, that can assume a non-negative integer value such as *mention* \in $\mathbb{N}_0 = \{0, 1, 2, ...\}$, and includes several zeros (which means no mentions for several days).

In particular, we consider the following model:

$$mentions_{i,t} = \alpha + \sum_{n=1}^{N} \beta_{in,t} Event_{n,t} + \gamma X_{i,t} + \mu_i + \tau_t + \varepsilon_{i,t}.$$
 (1)

where $mentions_{i,t}$ is the number of mentions of any relevant keyword in country *i* in day *t*; $Event_{n,t}$ are N = 30 dummy variables that indicate the policy event happening at EU level in a certain day, *t*; $X_{i,t}$ is a vector of control variables. In particular, we include as controls: the bitcoin return (in log), to account for the market developments in bitcoin prices; the local main stock market indices, to account for the behaviour of the stock markets for each Member State in the EU; the VIX index, as an indicator of uncertainty and stress in the general stock market. The panel is estimated for N = 20 country indicators (19 European Member States and the EU referred as a whole, which we include with its own keywords),

⁸See https://www.coingecko.com/it/api.

⁹These 10 cryptocurrencies were not only the most traded at the time of the data selection, but also those that are consistently more traded overtime according to CoinGecko, our source of data.

since we exclude the countries with less than 2 articles in the sample.¹⁰

The results of our estimation are presented in the fourth and fifth columns of Table C.1 in the Appendix. The coefficients are reported as transformed to incidence-rate ratios (i.e., $\exp(\beta)$ rather than β). For example, by looking at the estimated rate ratio of 3.401 for the CBDC announcement of 8 November 2021, the event would increase the number of mentions by 3.401 times while holding the other variables in the model constant. To have a positive effect on the news, the coefficient should be greater than one and significant. Rate ratios equal to zero mean that the Poisson coefficient is negative, thus in correspondence to the event there are fewer mentions than usual. From Table C.1 we notice that all CBDCrelated events have a positive and in most cases significant coefficient, meaning that we do observe a significant increase in mentions of our set of keywords during these events. It seems that the cryptocurrency world and the potential adoption of a CBDC are strongly interconnected, at least from the point of view of the news writers. The same attention is devoted only to a part of the Digital Finance Package events, notably the approval of the Data Governance Act (16 May 2022), the publication of the European Pilot Regime (2 June 2022), the political agreement and endorsement of MiCA (30 June and 5 October 2022). The date of the potential further development of the crisis management framework for cybersecurity (19 October 2021) has also a significant increase in mentions. For what concerns the control variables, the Bitcoin return has, as expected, a positive, significant and high value of rate ratio. Not surprisingly, stock market returns are not significant, showing a potential detachment between the crypto markets (and related topics) and the traditional stock markets. The VIX index is slightly lower than the unity, meaning that an increase in volatility would decrease the mentions by 0.976.

We also group event dates in three categories, as shown in Table 3, and we run the panel Poisson model of Equation (1) for the group of events, including the control variables. Table 4 reports the results of the estimation. As pointed out before, we notice that in correspondence to CBDC events, there is a substantial increase in mentions for our keywords. The coefficient is roughly equal to ~ 3.5 and stable across specifications, also including the Bitcoin returns. Events related to the Digital Finance Package are significant but with a coefficient much

¹⁰The countries excluded are Bulgaria, Cyprus, Croatia, Luxembourg, Malta, Romania, Slovenia, Slovakia.

smaller, equal to ~ 1.5 . Overall, the analysis presented shows that there is evidence of peaks in news in correspondence of the date of new developments in EU legislation.

	(1)	(2)	(2)	(4)	(5)
	(1)	(2)	(3)	(4)	(0)
# Mentions					
CBDC	3.571***	3.496***	3.582***	3.551***	3.588***
	(0.761)	(0.739)	(0.783)	(0.772)	(0.774)
Digital Finance Package	1.441**	1.490**	1.433**	1.486**	1.501**
	(0.256)	(0.272)	(0.252)	(0.269)	(0.269)
Cybersecurity	1.646	1.698	1.625	1.668	1.572
	(0.535)	(0.552)	(0.524)	(0.538)	(0.511)
Bitcoin return	· · · ·	87.038***	· · · ·	90.168***	96.561* ^{**}
		(97.928)		(102.212)	(114.641)
Eurostoxx return			0.405	0.157	0.020
			(1.159)	(0.443)	(0.078)
VIX			. ,		0.977^{***}
					(0.005)
Observations	$29,\!180$	29,180	$28,\!480$	$28,\!480$	$28,\!480$
Number of countries	20	20	20	20	20
Incidence-rate ratio. Rob	ust standar	d errors in p	arentheses.	*** p<0.01,	** p<0.05, * p<0.1

Table 4: Topics and frequency of mentions about cryptocurrencies in the news

4 News sentiment

The simple mention of one (or more) keywords provides information about the general perceived importance of the topic, but this is just one dimension of the issue. One way to exploit the power of the news is to categorise opinions to determine the attitude of the writer toward a particular topic, that can be positive, negative, or neutral. The sentiment analysis thus allows an understanding of whether the crypto-related news could perceive also regulatory developments, albeit we do not directly control for EU-regulations news.

We compute sentiment indicators based on existing dictionaries widely used in the economic and financial literature, such as Loughran and McDonald (2011), Renault (2017), Nielsen (2011), and Shapiro et al. (2022). The sentiment indicators by Loughran and Mc-Donald (2011) and Shapiro et al. (2022) are based on a financial dictionary of negative and positive words. Nielsen (2011) is based on a more general dictionary, and it is specific for microblogs, while Renault (2017) is used to analyze sentiment regarding online investment.¹¹ Descriptive statistics for the overall sample are presented in Table 5. We notice that for all but Nielsen (2011), the average sentiment is slightly negative. This suggests a mild association between negative news and crypto-related topics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Avg. Sentiment Loughran-McDonald	3,325	-0.316	0.374	-1.000	1.000
SD Sentiment Loughran-McDonald	1,732	0.134	0.177	0.000	1.414
Avg. Sentiment Renault	3,369	-0.003	0.115	-0.443	0.504
SD Sentiment Renault	1,753	0.039	0.051	0.000	0.389
Avg. Sentiment Shapiro et. al.	$3,\!371$	-0.023	0.070	-0.503	0.278
SD Sentiment Shapiro et. al.	1,754	0.025	0.033	0.000	0.241
Avg. Sentiment Nielsen	$3,\!354$	0.269	0.563	-2.000	3.000
SD Sentiment Nielsen	1,745	0.214	0.274	0.000	1.922

Table 5: Descriptive statistics of different sentiment measures

To complement the descriptive statistics, we provide a visual representation of the sentiment distribution within our event groups. Figure 1 shows that there is substantial heterogeneity across dictionaries. For CBDC-related events and Digital Finance Package events, news tends to exhibit a negative sentiment, albeit with considerable dispersion across methodologies. There is no clear pattern for Cybersecurity. Also in this case, Nielsen (2011) dictionary gives a completely different picture, and it seems that it is not well suited for our purposes.

We now use the following panel regression with fixed effects to find the most effective dictionary for estimating the average expected return of a crypto asset or stock index, considering news-related factors:

$$CryptoReturns_{j,t} = \alpha + \beta_1 Market_t + \beta_2 mentions_t + \theta X_t + \tau_t + \varepsilon_{i,t}, \tag{2}$$

$$StockReturns_{i,t} = \alpha + \beta_1 Market_t + \beta_2 mentions_{i,t} + \theta X_{i,t} + \tau_t + \varepsilon_{i,t}, \tag{3}$$

¹¹Sentiment is calculated using dictionary-based techniques, which offer a high degree of interpretability and have been validated in extensive economic and financial literature (Barbaglia et al., 2024).



Average sentiment by policy events and methodology



Figure 1: Average sentiment by group of events and methodology

where $Market_t$ represents the benchmark stock (or crypto) market index, $mentions_{i,t}$ is the number of mentions of any keyword related to crypto assets and digital finance, and $X_{i,t}$ is a vector that contains the average sentiment and the standard deviation of the sentiment for each of the four measures of sentiment presented before. The differences between Equation (2) and Equation (3) are that, in the first case, mentions are aggregated across days t, while in the second both mentions and the measures of sentiment are country-specific (note the index i in the equation). Fixed effects are at the cryptocurrency level in Equation (2) and at country level in Equation (3). We include both the average and the standard deviation of the sentiments since the former provides us with an indication of whether the news is positive or negative, while the latter represents the dispersion of such sentiment. A large value implies a large dispersion, thus there is uncertainty about whether the news is positive or negative. A smaller value instead signals that there is a sort of agreement about the tone of the news.

Table 6 presents the results of the estimation of Equation (2). The market index (BBG Crypto Index) is positive and statistically significant as expected, as well as the mentions. Interestingly, the sentiment measures have different levels of significance depending on the dictionary used. Common to all estimations are the sign of the coefficients, positive for the sentiment and negative for the standard deviation. In other words, when there are positive news, these are associated with positive cryptocurrency returns. The negative sign of the standard deviation has an important interpretation. A lower dispersion is associated with positive returns, meaning that when there is uncertainty, crypto traders prefer to sell, pushing the prices down. Despite all methodologies being related to the economic and financial sector, the one performing better in our data is the Renault (2017), where both coefficients are highly statistically significant.

Table 7 presents the results of the estimation of Equation (3) for the stock market indices. The results are quite similar in terms of signs and significance. However, all news-related variables (mentions and sentiments) have a much lower explanatory power in this case, smaller coefficients and in some cases, they are not as significant as in Table 6. The reason for this behaviour is related to the selection of articles and keywords, that are all related to

Cryptocurrencies Returns	(1)	(2)	(3)	(4)	(5)
BBG Crypto Index Return	0.093***	0.092***	0.089***	0.091***	0.090***
Montions	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)
Mentions		(0.001)	(0.001)	(0.001)	(0.001)
Avg. Sentiment Loughran-McDonald		0.006**		(<i>)</i>	
SD Sentiment Loughran-McDonald		(0.002)			
SD Schement Loughran-McDonald		(0.004)			
Avg. Sentiment Renault			0.031^{***}		
SD Sentiment Renault			(0.007) - 0.028^{***}		
			(0.007)		
Avg. Sentiment Shapiro et. al.				0.030^{***}	
SD Sentiment Shapiro et. al.				-0.022^*	
Aug Continent Nielson				(0.011)	0.001
Avg. Sentiment Meisen					(0.001)
SD Sentiment Nielsen					-0.007***
Constant	0.001***	0.001*	0.001	-0.000	(0.001) -0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Observations	9.504	9.504	9.504	9.504	9.504
Adj R2	0.00653	0.00973	0.0110	0.00889	0.00900
Number of Cryptocurrencies	10	10	10	10	10

Table 6: Panel regression: cryptocurrency returns and sentiment

Robust standard errors in parentheses. Fixed effects by cryptocurrency. *** p<0.01, ** p<0.05, * p<0.1

the crypto and digital finance world. The two worlds (stock markets versus crypto markets) do not have much in common, albeit there might be spillovers from one to the other. Nevertheless, since our set of events under investigation is related to these topics, we choose also in this case the Renault (2017) dictionary (and related measures of sentiment) for the subsequent analyses.

Stock market Indices	(1)	(2)	(3)	(4)	(5)
Eurostoxx 50 Return	0.7318***	0.7318***	0.7316***	0.7314***	0.7314***
Mentions	(0.056)	(0.056) 0.0000	(0.056) 0.0000	(0.056) 0.0000	(0.056) 0.0000
Avg. Sentiment Loughran-McDonald		(0.000) 0.0001 (0.000)	(0.000)	(0.000)	(0.000)
SD Sentiment Loughran-McDonald		-0.0006* (0.000)			
Avg. Sentiment Renault		(0.000)	0.0013**		
SD Sentiment Renault			(0.001) 0.0003 (0.001)		
Avg. Sentiment Shapiro et. al.			(0.001)	0.0020*	
SD Sentiment Shapiro et. al.				(0.001) -0.0017 (0.001)	
Avg. Sentiment Nielsen				(0.001)	0.0003***
SD Sentiment Nielsen					(0.000) -0.0002 (0.000)
Constant	0.0000^{***} (0.000)	0.0001^{***} (0.000)	0.0000^{**} (0.000)	0.0001^{***} (0.000)	(0.0000) (0.000)
Observations	29,000	29,000	29,000	29,000	29,000
Adj R2	0.577	0.577	0.577	0.577	0.577
Number of countries	20	20	20	20	20

Table 7: Panel regression: stock market returns and sentiment

Robust standard errors in parentheses. Fixed effects by country. *** p<0.01, ** p<0.05, * p<0.1

5 Impact of crypto news on prices

5.1 Methodology

There are several methods to assess if and how an event could affect financial markets or the crypto market. We have chosen to use the standard event study framework, as it provides easily interpretable results and facilitate comparisons across different market types.¹² We

 $^{^{12}}$ There are several references for the standard event study framework. Among others, the most cited is probably MacKinlay (1997), which we refer for further details.

first define the so-called abnormal returns (AR) for an entity *i* at time *t*:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}|X_t),$$
(4)

where $R_{i,t}$ is the actual return in the event window and $E(R_{i,t}|X_t)$ is the expected return given the information at time t, which is outside the event window. The most common estimation method for $E(R_{i,t}|X_t)$ is through the Single Index Model (SIM), where the "normal" returns depend on the estimation of a market model as follows:

$$AR_{i,t} = R_{i,t} - E(\alpha + \beta_i R_{m,t}), \tag{5}$$

where $R_{m,t}$ is the market return at time t, usually a broad market index that captures the performance of the overall universe of stocks or crypto assets. Our estimation of AR includes also additional factors linked to news and sentiment, as explained before. Our final model to estimate AR thus reads as follows:

$$AR_{i,t} = R_{i,t} - E(\alpha + \beta_i R_{m,t} + \gamma_i mentions_{i,t} + \theta X_{i,t}), \tag{6}$$

where $mentions_{i,t}$ is the number of mentions of any keyword related to crypto assets and digital finance, and $X_{i,t}$ is a vector that contains the average sentiment and the standard deviation of the sentiment using the dictionary by Renault (2017). Once AR are calculated, cumulative abnormal returns (CAR) are aggregated as follows:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t},$$
(7)

where t_1 and t_2 are the intervals of the event window (outside the estimation window). Given that we pool several events and several entities (stock indices and cryptocurrencies), we perform one additional aggregation for AR and CAR, calculating the Average AR and CAR, which we call AAR and CAAR, respectively:

$$AAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{i,t}$$
 and $CAAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AAR_t.$ (8)

We run several statistical tests to assess the significance of the event study estimates. In fact, to assume economic relevance, abnormal returns should be statistically significant according to ad-hoc tests. Specifically, we include in our results the following:

- 1. *t*-stat assuming cross-sectional independence;
- 2. *t*-stat including the Crude Dependence Adjustment (CDA) as in Brown and Warner (1980) and Brown and Warner (1985);
- 3. *t*-stat according to Patell (1976);
- 4. t-stat according to Patell (1976) with Kolari and Pynnönen (2010) adjustments;
- 5. t-stat as in Boehmer et al. (1991) to correct for event-induced variance in cross section;
- 6. t-stat as in Kolari and Pynnönen (2010) to account for cross-correlation;
- 7. *n*-stat rank test from Corrado (1989) and Corrado and Zivney (1992).

All test are calculated for both the AAR and the CAAR, and the value of the statistic is reported in the results tables.

5.2 Cryptocurrencies

One of the characteristics of most cryptocurrencies is their decentralization, meaning they are not issued and regulated by a Central Bank and operate in a distributed ledger (DLT) called the "blockchain". The blockchain is a network of computers spread across the world, without a single point of control, and transactions are validated inside the network using different consensus mechanisms. As a result, there is no need for a central authority, and cryptocurrencies can be sent and received anywhere in the world. Traders of cryptocurrencies vary from individuals to professional traders and institutional investors, who engage in trading for speculative reasons (e.g. generating returns on price movements) or to a lesser extent to execute transactions that require digital currencies.

The EC has been working on creating a regulatory framework that ensures consumer protection, market integrity, and financial stability without impeding innovation in the digital economy space. Given the worldwide nature of cryptocurrencies, it could well be that regulatory events localised in the EU might have little impact on prices. Nevertheless, we run the event study analysis since all outcomes are of interest. On the one hand, if the AAR are significant, it might be that the crypto markets are incorporating the information



Figure 2: Event study and CAAR for Cryptocurrencies.

into prices, and thus the regulation is viewed as a potential threat or opportunity. On the other hand, a non-significant set of values can be seen as a potential detachment between regulation and markets.

Table 8 reports the results for the AAR in the event window [-3,+3], where 0 represents the event date, and Figure 2 shows the evolution through the window of the CAAR. For the panel on CBDC events, we see that the estimation is significant three days before, at the event date, and three days after. In all three cases, the AAR are negative, with a peak of -4.377% 3 days after the event. This result is consistent with the analysis presented in Table 4, where CBDC events attract a lot of attention in terms of news and mentions of the selected keywords. Since the coefficients are negative, apparently the market of cryptocurrencies perceives the introduction of a CBDC as a potential threat to their business. We also note that in our panel we have two stablecoins (Tether and USDcoin), whose existence might be challenged in the presence of a fully operational CBDC. For the Digital Finance Package (middle panel) although the returns in the event window are all negative except on day two, there are no significant AARs. In this case, the market seems to be neutral about the events. For Cybersecurity events, interestingly the market reaction is strong and significant only on the day of the events. This result creates somehow a link between potential illicit activities (that will be monitored and banned) and the market of cryptocurrencies.

The overall results cumulated across days are presented in Table 9 for different event windows. For CBDC, the overall set of events in the full event window [-3,+3] yields a -5.6% negative return for the panel of cryptocurrencies. There is some evidence of anticipatory effect for the Digital Finance Package in the window [-3,-1], albeit not strongly significant.

Time	AAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crypt	tocurrenc	ies Return	s - CBDC	Events				
-3	-0.902%	-1.830*	-0.840	-2.241**	-0.963	-2.500**	-1.075	-1.298
-2	0.474%	0.927	0.441	0.602	0.259	0.737	0.317	0.632
-1	0.176%	0.352	0.164	1.015	0.436	1.092	0.469	0.274
0	-1.141%	-2.187**	-1.062	-2.128^{**}	-0.915	-2.761^{***}	-1.187	-0.906
1	-0.384%	-0.763	-0.358	-1.665^{*}	-0.716	-1.903*	-0.818	-0.999
2	0.562%	1.113	0.523	1.207	0.519	0.770	0.331	0.871
3	-4.377%	-8.747***	-4.077***	-8.563***	-3.681***	-3.191***	-1.372	-1.024
Crypt	tocurrenc	ies Return	s - Digital	Finance P	ackage Ev	ents		
-3	-0.870%	-2.610**	-1.021	-2.091**	-0.833	-1.498	-0.597	-1.279
-2	-0.383%	-1.161	-0.450	-2.296**	-0.915	-1.768*	-0.704	-0.587
-1	-0.411%	-1.263	-0.483	-1.172	-0.467	-0.863	-0.344	0.040
0	-0.210%	-0.639	-0.247	-1.456	-0.580	-1.313	-0.523	-0.065
1	-0.334%	-1.005	-0.392	-1.536	-0.612	-1.241	-0.494	0.125
2	0.925%	2.825^{***}	1.085	1.452	0.579	1.541	0.614	0.652
3	-0.279%	-0.820	-0.327	-0.967	-0.385	-0.931	-0.371	-0.688
Crypt	tocurrenc	ies Return	s - Cybers	ecurity Ev	ents			
-3	4.545%	3.586***	2.726***	3.068***	1.383	1.182	0.533	0.716
-2	1.145%	1.298	0.687	1.009	0.455	0.988	0.445	0.519
-1	0.620%	0.708	0.372	0.965	0.435	1.170	0.527	0.538
0	-2.297%	-2.662***	-1.378	-2.526**	-1.139	-2.324**	-1.048	-1.665^{*}
1	1.269%	1.484	0.761	1.504	0.678	2.889***	1.302	1.157
2	1.354%	1.564	0.812	0.979	0.441	1.027	0.463	0.689
3	0.139%	0.158	0.084	0.148	0.067	0.182	0.082	-0.186

 Table 8: Average Abnormal Returns: Cryptocurrencies

Notes: AAR stands for Average Abnormal Returns. The tests reported are: (1) t-stat assuming cross-sectional independence; (2) Brown and Warner (1980/1985); (3) Patell (1976); (4) Patell (1976) with KP (2010) adjustment; (5) Boehmer et al. (1991); (6) Kolari and Pynnönen (2010); (7) Corrado (1989) / Corrado and Zivney (1992). *** p<0.01, ** p<0.05, * p<0.1

Finally, for cybersecurity events, before the events, there are positive and significant returns, which are only partially offset on the day of the event. All in all, the analysis shows that CBDC developments and the cryptocurrency world appear to be strongly related, while a more nuanced and neutral view belongs to the Digital Finance Package.

Time	CAAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Crypt	ocurrenci	ies Returns	s - CBDC	Events				
[-3;3]	-5.591%	-4.203***	-1.968*	-5.781***	-2.485**	-2.968***	-1.276	-0.926
[-3;-1]	-0.252%	-0.295	-0.135	-1.228	-0.528	-1.345	-0.578	-0.269
[0;1]	-1.524%	-2.167^{**}	-1.004	-3.305***	-1.421	-3.602***	-1.548	-1.367
[0;3]	-5.340%	-5.350***	-2.487**	-6.890***	-2.961***	-2.818***	-1.211	-1.032
Crypt	ocurrenci	ies Returns	s - Digital	l Finance I	Package Ev	rents		
[-3;3]	-1.563%	-1.823*	-0.693	-5.579***	-2.223**	-2.781***	-1.108	-0.681
[-3;-1]	-1.665%	-2.985***	-1.128	-4.392***	-1.750^{*}	-2.321^{**}	-0.925	-1.040
[0;1]	-0.544%	-1.194	-0.452	-2.542^{**}	-1.013	-2.418^{**}	-0.963	0.025
[0;3]	0.102%	0.158	0.060	-2.187**	-0.871	-1.610	-0.641	-0.024
Crypt	Cryptocurrencies Returns - Cybersecurity Events							
[-3;3]	6.776%	2.950***	1.536	4.204***	1.895^{*}	1.602	0.722	0.669
[-3;-1]	6.311%	4.209***	2.185^{**}	4.339***	1.956^{*}	1.706^{*}	0.769	1.050
[0;1]	-1.028%	-0.846	-0.436	-1.463	-0.659	-1.483	-0.668	-0.317
[0;3]	0.466%	0.271	0.140	-0.824	-0.371	-0.737	-0.332	0.024

 Table 9: Cumulative Average Abnormal Returns: Cryptocurrencies

Notes: CAAR stands for Cumulative Average Abnormal Returns. The tests reported are: (1) t-stat assuming cross-sectional independence; (2) Brown and Warner (1980/1985); (3) Patell (1976); (4) Patell (1976) with KP (2010) adjustment; (5) Boehmer et al. (1991); (6) Kolari and Pynnönen (2010); (7) Corrado (1989) / Corrado and Zivney (1992). *** p<0.01, ** p<0.05, * p<0.1

5.3 Stock market indices

The interplay between stock markets, cryptocurrency assets, and regulatory measures concerning digital finance is complex for several reasons. Firstly, the cryptocurrency realm only partially intersects with the stock markets: while a clear link exists for financial firms and banks, drawing parallels with the manufacturing sector, for example, and the dynamics of cryptocurrencies and their regulations is more challenging. Secondly, the stock market's response to such policy changes is influenced by many factors, including costs and potential risks associated with these shifts. Furthermore, given the emerging nature of digital finance, market reactions are likely influenced not just by these initiatives but also by broader economic conditions and investor sentiment.

On the one hand, new regulations around a topic as controversial as cryptocurrency can provide reassurance to the stock markets. On the other hand, a negative market reaction might be interpreted as a missed chance by regulators to fully capitalize on the potential of digital finance. The results of the event studies of Table 10 and Table 11 (and graphically on Figure 3) represent both views. For CBDC events, the stock market reacts negatively before and after the event, but at the event date, there is a positive and statistically significant rebound. In the entire event window, the overall return is negative (-0.482%).



Figure 3: Event study and CAAR for Stock Market Indices.

For the Digital Finance Package, there is a negative reaction the day after the event. This result supports the conjecture that the new regulation is viewed as a missed opportunity, or that a more stringent regulation can reduce the opportunities for the financial sector (which is usually a consistent part of the stock indices) to integrate digital finance services into their business. Finally, an increase in resilience against cybersecurity is positively judged by the stock markets, since there is a positive (but mildly significant) reaction the day after the events.

To conclude, as expected, we do not find a strong reaction from stock markets, given that for the news the set of keywords we select is strongly related to digital finance and the crypto world. In addition, our set of events is aimed at influencing the cryptocurrency landscape, rather than the stock markets. Nevertheless, we do find some interesting and significant results, especially for CBDC announcements, in continuity with the analysis on cryptocurrencies presented in the previous section.

Time	AAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stock	Market	Returns -	CBDC Eve	ents				
-3	-0.088%	-1.676*	-1.184	-2.043**	-1.326	-2.030**	-1.317	-0.576
-2	-0.011%	-0.213	-0.151	-0.459	-0.298	-0.474	-0.307	-0.171
-1	-0.283%	-5.391***	-3.785***	-5.657***	-3.671***	-2.460^{**}	-1.596	-1.212
0	0.245%	4.436^{***}	3.279^{***}	3.951^{***}	2.564^{**}	2.442^{**}	1.585	1.553
1	-0.151%	-2.863***	-2.025**	-3.336***	-2.165^{**}	-2.801***	-1.818*	-1.723^{*}
2	-0.032%	-0.614	-0.431	-1.050	-0.682	-1.033	-0.670	-0.175
3	-0.161%	-3.032***	-2.153**	-2.904***	-1.884*	-1.879*	-1.220	-1.758*
Stock	Market	Returns -	Digital Fin	ance Pack	age Events			
-3	0.094%	2.630**	1.580	1.796^{*}	1.017	1.861*	1.054	0.972
-2	0.075%	2.051^{**}	1.247	1.540	0.873	1.386	0.785	0.693
-1	-0.036%	-1.000	-0.600	-1.890*	-1.071	-1.824*	-1.033	-1.375
0	-0.050%	-1.376	-0.829	-1.234	-0.699	-1.085	-0.615	-0.797
1	-0.166%	-4.512***	-2.782***	-5.688***	-3.222***	-3.301***	-1.870*	-1.437
2	0.049%	1.356	0.822	1.188	0.673	1.042	0.590	0.198
3	0.024%	0.667	0.405	0.929	0.526	1.325	0.751	0.200
Stock	Market	Returns -	Cybersecu	rity Events	5			
-3	-0.128%	-0.957	-1.094	-0.589	-0.411	-0.610	-0.426	-0.896
-2	-0.036%	-0.420	-0.307	-0.118	-0.082	-0.092	-0.064	-1.280
-1	0.052%	0.578	0.444	0.275	0.192	0.272	0.189	-0.220
0	0.079%	0.893	0.675	0.582	0.406	0.516	0.360	0.084
1	0.157%	1.805^{*}	1.337	2.394**	1.669^{*}	2.226^{**}	1.552	1.914^{*}
2	0.133%	1.548	1.132	1.191	0.831	1.264	0.881	0.719
3	-0.043%	-0.498	-0.364	-0.807	-0.562	-1.159	-0.808	-0.344

Table 10: Average Abnormal Returns: Stock Market Indices

Notes: AAR stands for Average Abnormal Returns. The tests reported are: (1) t-stat assuming cross-sectional independence; (2) Brown and Warner (1980/1985); (3) Patell (1976); (4) Patell (1976) with KP (2010) adjustment; (5) Boehmer et al. (1991); (6) Kolari and Pynnönen (2010); (7) Corrado (1989) / Corrado and Zivney (1992). *** p<0.01, ** p<0.05, * p<0.1

Time	CAAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Stock	Markets	Returns -	CBDC Ev	ents				
[-3;3]	-0.482%	-3.420***	-2.438**	-6.677***	-4.333***	-3.368***	-2.186**	-1.913*
[-3;-1]	-0.382%	-4.262***	-2.957***	-5.635***	-3.656***	-3.035***	-1.970^{*}	-1.522
[0;1]	0.094%	1.268	0.887	1.592	1.033	0.842	0.547	-0.290
[0;3]	-0.099%	-0.944	-0.664	-0.466	-0.302	-0.215	-0.139	-1.061
Stock	Markets	Returns -	Digital Fi	nance Pack	age Events	5		
[-3;3]	-0.009%	-0.100	-0.059	-0.531	-0.301	-0.306	-0.173	-0.430
[-3;-1]	0.133%	2.178^{**}	1.286	1.794^{*}	1.016	1.334	0.756	0.243
[0;1]	-0.216%	-4.310***	-2.553**	-5.256^{***}	-2.978^{***}	-2.951^{***}	-1.672^{*}	-1.554
[0;3]	-0.143%	-2.010**	-1.192	-4.106***	-2.326**	-2.292**	-1.299	-0.823
Stock	Markets	Returns -	Cybersecu	rity Event	s			
[-3;3]	0.214%	0.931	0.689	1.029	0.718	0.474	0.331	-0.060
[-3;-1]	-0.112%	-0.755	-0.553	-0.514	-0.358	-0.292	-0.203	-1.489
[0;1]	0.236%	1.928^{*}	1.423	2.275^{**}	1.586	1.869^{*}	1.303	1.379
[0;3]	0.327%	1.887^{*}	1.390	2.559^{**}	1.784^{*}	1.632	1.138	1.025

Table 11: Cumulative Average Abnormal Returns: Stock Market Indices

Notes: CAAR stands for Cumulative Average Abnormal Returns. The tests reported are: (1) t-stat assuming cross-sectional independence; (2) Brown and Warner (1980/1985); (3) Patell (1976); (4) Patell (1976) with KP (2010) adjustment; (5) Boehmer et al. (1991); (6) Kolari and Pynnönen (2010); (7) Corrado (1989) / Corrado and Zivney (1992). *** p<0.01, ** p<0.05, * p<0.1

6 Conclusion

The rapid growth of digital finance, notably digital currencies, has led to the need for regulation and oversight. The EC has taken steps to address this need through various proposals and legislative packages. This paper aims to understand the extent to which news about digital finance, particularly cryptocurrencies, is covered and discussed in EU countries during relevant policy developments and discussions. In addition, the analysis wants to uncover the relationship between news sentiment and cryptocurrency prices in the EU.

The analysis finds three main results. First, we observe an increase in news in correspondence with the introduction of pertinent developments in EU legislation, in particular about Central Bank Digital Currencies. Second, through the use of ad-hoc sentiment indicators, we discover a positive correlation between news sentiment about crypto markets and the returns of cryptocurrencies, as well as general stock market returns. Third, our event study shows that the introduction of new EU regulations on digital finance and crypto currencies is perceived as a negative shock by financial markets, especially when considering the reaction of cryptocurrency returns to new CBDC legislation. However, regulation strengthening cybersecurity is perceived as a positive development by stock markets.

Results highlight that news sentiment has some explanatory power with respect to returns in crypto markets. Moreover, we emphasize the different reactions of digital assets to policy actions, depending on the area of intervention. These insights may prove valuable for a range of stakeholders: regulatory bodies can gain insights into the potential impact of legislative changes on public perception and market dynamics, investors may benefit from a deeper understanding of how news sentiment influences cryptocurrency prices in order to hedge against speculative movements in digital currencies. Future research could explore the role of social media sentiment alongside news article and provide a more comprehensive picture of investors' behavior.

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Appendix

A Country keywords

Country	Keywords
Austria	austria, austrian, vienna
Belgium	belgium, belgian, belgica, brussels, antwerp, european capital,
	eu capital, wallonia, flanders
Bulgaria	bulgaria, bulgarian, sofia
Croatia	croatia, croatian, croat, zagreb
Cyprus	cyprus, cypriot, cypriote, nicosia
Czech Republic	czech republic, czech, prague, praha
Denmark	denmark, danish, dane, copenhagen
Estonia	estonia, estonian, tallinn
Finland	finland, finn, finnish, helsinki
France	france, french, paris
Germany	germany, german, deutschland, deutsches, berlin, frankfurt
Greece	greece, greek, hellenic, athens
Hungary	hungary, hungarian, budapest
Ireland	eire, ire, republic of ireland, ireland, irish, dublin
Italy	italy, italian, italic, italia, rome, milan
Latvia	latvia, latvian, riga
Lithuania	lithuania, lithuanian, vilnius
Luxembourg	luxembourg, luxemburger, luxembourg-ville
Malta	malta, maltese, valletta
Netherlands	netherlands, holland, amsterdam, rotterdam, den haag, dutch,
	hollander
Poland	poland, polish, pole, warsaw
Portugal	portugal, portuguese, lisbon
Romania	romania, romanian, bucharest
Slovakia	slovakia, slovak, slovakian, bratislava
Slovenia	slovenia, slovenian, ljubljana
Spain	spain, espana, spanish, spaniard, madrid, barcelona, catalonia,
	hispania, hiberia, hiberian
Sweden	sweden, swedish, swede, stockholm
European Union	europe, european

Table A.1: Keywords for each country of interest

B Descriptive statistics of the data

Variable	Ν	mean	sd	\min	max	
Cryptocurrencies - Log Returns						
Bitcoin	1424	0.12%	3.54%	-43.37%	17.60%	
USDcoin	1424	0.00%	0.27%	-2.85%	2.87%	
Tether	1424	0.00%	0.26%	-1.97%	2.50%	
StakedTether	1067	0.11%	4.43%	-29.81%	23.60%	
Solana	1322	0.31%	7.28%	-54.82%	38.45%	
Ripple	1424	0.08%	5.82%	-54.95%	54.45%	
Ethereum	1424	0.19%	4.69%	-56.31%	21.94%	
Dogecoin	1424	0.25%	7.88%	-50.71%	147.91%	
Cardano	1424	0.17%	5.28%	-52.44%	26.92%	
Binancecoin	1424	0.20%	5.06%	-55.90%	55.27%	
Stock Indices - Log Returns						
AT	800	0.01%	1.57%	-14.67%	10.21%	
BE	814	0.00%	1.31%	-15.33%	7.36%	
CZ	829	0.04%	1.09%	-8.16%	7.37%	
DE	808	0.03%	1.37%	-13.05%	10.41%	
DK	794	0.02%	1.24%	-8.37%	4.01%	
EE	829	0.07%	0.90%	-9.58%	5.20%	
EL	829	0.05%	1.43%	-11.22%	7.50%	
ES	812	0.01%	1.36%	-15.15%	7.53%	
FI	829	0.01%	1.25%	-10.68%	6.66%	
FR	814	0.03%	1.35%	-13.10%	8.06%	
HU	791	0.06%	1.53%	-12.27%	6.00%	
IE	829	0.05%	1.45%	-10.46%	6.71%	
IT	807	0.03%	1.51%	-18.54%	8.55%	
LT	829	0.06%	1.25%	-16.33%	12.09%	
NL	814	0.03%	1.26%	-11.38%	8.59%	
PO	778	-0.02%	1.65%	-14.25%	8.10%	
PT	814	0.00%	1.15%	-10.27%	7.53%	
SE	790	0.01%	1.26%	-11.17%	6.85%	
Other variables						
Eurostoxx Return	1450	0.01%	1.19%	-13.24%	8.83%	
BBG Crypto Index Return	1006	0.19%	4.55%	-29.61%	19.83%	
VIX	1459	22.72	8.35	12.07	82.69	

Table B.1: Descriptive statistics of the data

C Events

Date	Type	Full text event	Baseline	W. controls
03 November 2020	CBDC	Eurogroup discusses benefits and challenges of a	1.749	2.838**
		digital euro		
19 January 2021	CBDC	Agreement. The EC and the ECB agreed to work	1.020	0.955
		together to analyse various design options and the		
		related regulatory implications of the digital euro.		
08 November 2021	CBDC	Eurogroup discusses policy objectives and uses of	3.401***	2.715**
		the digital euro		
25 February 2022	CBDC	Eurogroup takes stock of the state of play of the	1.166	1.353
		work on a digital euro		
07 November 2022	CBDC	High level conference: The EC and the ECB jointly	5.686***	6.716***
		organised a high level conference entitled "Towards		
		a legislative framework enabling a digital euro for		
		citizens and businesses".		
28 June 2023	CBDC	The EC adopted a legislative proposal on a digital	3.907***	3.094***
		euro for the EU.		
18 October 2023	CBDC	Decision by the ECB's Governing Council to	8.066***	7.436***
		conclude the investigation phase and move to the		
		preparation phase of the digital euro project.		
15 December 2020	DFP	EC proposal on digital market act	0.000***	0.000***
27 May 2021	DFP	Ministers debate Digital Services Act package	1.458	1.130
24 November 2021	DFP	Council agreement on markets in crypto-assets and	0.000***	0.000***
		digital operational resilience		
25 November 2021	DFP	Council approves position on Digital Markets Act	0.000***	0.000***
		and Council approves position on Digital Services		
		Act		
23 February 2022	DFP	Data Act proposal	0.292^{*}	0.312
$11 {\rm \ May\ } 2022$	DFP	Digital finance: Provisional agreement reached on	1.069	1.364
		DORA		
16 May 2022	DFP	Council approves Data Governance Act	6.668***	6.417***

Table C.1: Timeline of events

Continued on next page

Date	Type	Full text event	Baseline	W. controls
02 June 2022	DFP	European Pilot Regime regulation published: it	4.300**	6.460***
		offers targeted regulatory exemptions to: MiFID II,		
		the Finality Directive, and the Central Securities		
		Depositories Regulation (CSDR), for the purpose of		
		testing blockchain technology in financial markets		
		and post-trade activities.		
23 June 2022	DFP	Data Governance Act entered into force	1.866	2.561
30 June 2022	DFP	Crypto-assets (MiCa). Political agreement between	1.516**	1.776***
		the European Parliament and the Council on a		
		regulatory framework for crypto-assets.		
14 September 2022	DFP	Council and Parliament sign Digital Markets Act	0.000***	0.000***
05 October 2022	DFP	Digital finance: MiCA agreement endorsed by	7.872***	7.653***
		ambassadors of EU member states		
16 November 2022	DFP	DSA entered into force	0.000***	0.000***
28 November 2022	DFP	Council adopts Digital Operational Resilience Act	0.000***	0.000***
16 January 2023	DFP	Digital operational resilience (DORA) came into	0.875	0.864
		force		
14 February 2023	DFP	EC launches European Regulatory Sandbox for	0.000***	0.000***
		Blockchain		
23 March 2023	DFP	"Pilot Regime" applies to market infrastructures	0.875	1.033
		based on a distributed ledger technology. Enter in		
		force		
20 April 2023	DFP	EU Parliament approval of MICA	0.292*	0.328
02 May 2023	DFP	DMA rules start to apply	0.583	0.614
09 June 2023	DFP	Publication of the Markets in Crypto-assets	1.166	0.930
		Regulation (MiCa) in the Official Journal.		
30 July 2020	Cyber	EU imposes the first ever sanctions against	0.583	0.531
		cyber-attacks		

Table C.1 – continued from previous page $% \left({{{\rm{C}}_{\rm{s}}}} \right)$

Continued on next page

Date	Туре	Full text event	Baseline	W. controls
02 December 2020	Cyber	Cybersecurity of connected devices – Council	1.166	1.372
		adopts conclusions. The Council approved		
		conclusions that acknowledge the increased use of		
		consumer products and industrial devices connected		
		to the internet and the related new risks for privacy,		
		information security and cybersecurity. The		
		conclusions set out priorities to address this crucial		
		issue, and to boost the global competitiveness of the		
		EU's Internet of Things industry by ensuring the		
		highest standards of resilience, safety and security.		
19 October 2021	Cyber	The Council adopted conclusions inviting the EU	3.188***	2.700***
		and Member States to further develop the EU		
		cybersecurity crisis management framework,		
		including by exploring the potential of a joint cyber		
		unit.		
		Bitcoin Return		93.522***
		Eurostoxx Return		0.037
		VIX Index		0.976***
		Observations	29180	28480
		Number of countries	20	20

Table C.1 – continued from previous page $% \left({{{\rm{C}}_{\rm{s}}}} \right)$

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