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Long and short-term Impacts of Regulation in the Cryptocurrency Market

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Abstract

Since cryptocurrencies were first created, the related markets have been known for their fluctuations, whether in terms of high volatility or illiquidity. Partially for those reasons, public authorities and regulators around the world have frequently attempted to regulate those markets. We aim in our study to examine whether cryptocurrency traders perceive market regulation in a beneficial way. Using an event study methodology for daily data covering the 2015–2019 period, we assess how regulatory news and events have affected returns in cryptocurrency markets. We further assess whether financial cryptocurrency characteristics and in particular their liquidity can explain cross-sectional variations in cryptocurrency return reactions. The results suggest that events that increase the probability of regulation adoption are associated with negative abnormal returns for the cryptocurrencies concerned. We also find that the magnitude of the return reactions is not the same across all the cryptocurrencies in our sample. We show that investors reacted less negatively for the most illiquid cryptocurrencies and for those that incurred more information asymmetry risk. Finally, we analyze a longer-term effect of regulatory events by studying the performance of cryptocurrencies. The risk-adjusted return in the pre-event period is positive and significant, but it appears not to be significantly different from zero in the post-event period.

Keywords:

Regulation; Cryptocurrency risk; Cryptocurrency return; Market liquidity; Market efficiency.

JEL: G14; G18; G30

1. Introduction

“Bitcoin is not unregulated. It is regulated by algorithm instead of being regulated by government bureaucracies.” Andreas M Antonopoulos¹

The massive collapse of the banking sector caused by the 2008 financial crisis, on the one hand, and the insecurities in financial institutions, on the other, led to the rigorous development of cryptocurrencies. That growth in cryptocurrencies has attracted the attention of scholars and professionals. According to the CoinMarketCap website, at the time of writing this article (February 2020), there were around 5,000 existing cryptocurrencies². Almost all of those share the same operating process. They are independent of any third party such as the central bank and are exchanged between users through a decentralized (peer-to-peer) system based on blockchain technology. The system works through a consensus mechanism among participants to verify transactions (Tschorsch and Scheuermann, 2016). Since the development of Bitcoin (Nakamoto, 2008), several other cryptocurrencies have emerged, either by improving that existing technology (e.g., Ether (Buterin, 2015)) or being developed for special use (e.g., Ripple for the financial industry (Schwartz et al., 2015)).

The cryptocurrency market is both complex, due to the high number of cryptocurrencies on the market, and exposed to high risks, given the frequent and large price fluctuations (Bouri et al., 2019). Moreover, the anonymity of most cryptocurrency users also plays a role in that complexity. The market’s high risks and complexity have led to an ongoing debate between policymakers and financial institutions regarding its regulation. Although there is wide consensus (e.g., (Carney, 2018), Central Bank Governors, Financial Stability Board (FSB 2018), US Securities and Exchange Commission (SEC 2017), (Zetzsche et al., 2019)) regarding the necessity of regulating the cryptocurrency market, perspectives differ widely on how that should be achieved. The source of that controversy is the indeterminate legal nature of cryptocurrencies. Some governments consider them to be assets, whereas others consider them to be a transfer of payment or currency. In this article, we consider that cryptocurrencies could be considered as securities (Alfieri et al., 2019). In taking that view, we could consider cryptocurrency markets as behaving in a similar way to stock markets. However, as most

¹ Andreas M. Antonopoulos is one of the world’s foremost cryptocurrency and open blockchain experts.

² On April 17, 2020, available on: <https://coinmarketcap.com/>

stock markets are regulated to ensure stability and liquidity for investors, that raises the issue of cryptocurrency market regulation.

The various possible approaches to cryptocurrency regulation can be divided based on their three main objectives. According to the European Central Bank (ECB), cryptocurrency price stability is one of the most important objectives, as cryptocurrencies influence the velocity of money (Cox et al., 2015) and it is well known that the cryptocurrency market is very volatile (Akyildirim et al., 2020). The second objective is related to protecting consumers against illicit activities and money laundering transactions. Finally, as with any regulation, the third objective is to generate a new source of government revenues.

One of the other goals behind regulating the cryptocurrency market is to make it more liquid. Several financial and government reports (e.g., the FSB, the G20), and academic articles (e.g., Auer and Claessens, 2018) shed light on the liquidity risk. They suggest that several factors can make the cryptocurrency market illiquid, thus limiting the ability of its participants to buy or sell crypto assets. Besides, regulators seek to ensure consumer protection through restricting illicit activities and money laundering transactions. In the end, implementing new regulations for this market could generate important revenues for the governments concerned.

We reiterate that the cryptocurrency market is significant in that it was established in a decentralized manner, away from the supervision of any government or regulating institutions. Regulating the market through fiscal, restrictive, or even banning policies would certainly have a wide range of effects on its functioning.

The objective of this article is to examine whether cryptocurrency investors perceive market regulation in a beneficial way. First, we perform a short-term event study to assess and understand the market reaction to events and news that increase the probability of regulations being adopted. Second, we study the longer-term effect of regulation on cryptocurrency performance by focusing on periods before and after the accumulated events sample period.

We use an event study framework to assess how cryptocurrency users receive such regulatory news. From a methodological perspective, we follow the Armstrong et al. (2010) approach to investigating stock market reactions to the adoption of International Financial Reporting Standards (IFRS). We address two alternative scenarios in our article. First, investors could react positively to the adoption of regulation if they consider it likely to

improve market functioning and to reduce the risks incurred by investors in financial markets. According to the proponents, implementing a new regulation would increase confidence in the market, could protect investors from fraud, and new projects based on cryptocurrency markets could be more easily financed and supported. As a result, increased demand for cryptocurrencies might follow regulatory events. That should lead to a positive return market reaction. Conversely, the introduction of a new cryptocurrency regulation should decrease demand from investors attracted to that market by the absence of government or institutional regulatory roles.

As existing empirical evidence is scant and does not provide a clear perception of the overall market reaction concerning regulation implementation, we examine three-day market-adjusted returns for the cryptocurrencies included in our study. We selected 63 events extracted from the FACTIVE database and reports analysis for the period 2015 to 2019. We chose events across the world which refer to regulation adoption or might increase the likelihood of regulatory adoption.

Moreover, we argue that not all cryptocurrency returns react with the same strength to regulatory changes. We thus enlarge the scope of our study by measuring to what extent particular cryptocurrencies' financial characteristics explain cross-sectional variation in their return reactions. That approach is aimed at analyzing why cryptocurrency values evolve in different ways (i.e., if the reaction is positive/negative, the analysis identifies which cryptocurrencies' characteristics amplify/mitigate investor reactions).

As a second approach for deepening our understanding of how regulation affects cryptocurrency markets, we conduct an empirical analysis of cryptocurrency portfolio performance. To assess the impact of regulation events on longer-term performance, we consider a portfolio of the seven major cryptocurrencies³ (Bitcoin (BTC), Ether (ETH), Litecoin (LTC), Tether (USDT), Ripple (XRP), Dash (DASH), and Monero (XMR)). We use various methods to compare cryptocurrency portfolio performance before and after the occurrence of those regulatory events. As cryptocurrencies are treated as securities in this article, we appraise cryptocurrency performance using the risk-adjusted return from, in turn, the CAPM model, the Fama-French three-factor model (Fama and French, 1992), and the Carhart model (Carhart, 1997). We also apply the CAPM model using cryptocurrency data

³ We use seven cryptocurrencies, not thirty, due to data availability over the selected time period.

with the CRIX index as the market's portfolio proxy. Our analysis is drawn from June 24, 2016 to June 24, 2017 for the "pre-period" (i.e., before the regulation events), and from October 21, 2018 to October 21, 2019 for the "post-period" (i.e., after the regulation events).

Our study contributes to the existing literature on the regulation of cryptocurrencies. First, we study investor perceptions of new regulations by analyzing the cryptocurrency market return reactions to events that increase the probability of the market becoming more regulated. Second, we analyze whether specific cryptocurrency characteristics affect the return reactions to those events. Third, in contrast to the existing research on cryptocurrencies, the novelty of our study is in taking into consideration the impact of several regulation events on cryptocurrency portfolio performance (in the long term). The fourth contribution is methodological in nature, as we follow Armstrong et al. (2010) and Zhang (2007) by applying their methodology to the cryptocurrency market. We also consider various microstructure variables widely used in the prior literature on stock markets but much less so on the cryptocurrency market, such as the Amihud (2002) illiquidity measure and the Hou and Moskowitz (2005) delay measure.

The rest of this article is structured as follows. Section 2 presents a brief background to cryptocurrencies and their classification. Section 3 describes the events we consider as affecting regulation adoption, then presents our developed hypotheses. Section 4 lays out our data and research methodology before explaining our variable measurements. Section 5 presents the empirical results. Section 6 provides our conclusions.

2. Background to cryptocurrencies

2.1. What are cryptocurrencies and how are they classified?

No unique definition of cryptocurrencies has been established. They are 100 percent virtual assets, which exist only in computer networks, and are completely independent (i.e., not managed by governments or any third party) due to the absence of third parties in the transactions. Trading in cryptocurrencies differs from trading in stocks, since there is no specific organized exchange market (e.g., the New York Stock Exchange). They are instead traded on various informal internet platforms (e.g., Coinbase), which thus play a crucial role in the exchange of cryptocurrencies. Those platforms are the only link between the seller and the buyer through which they can trade directly with each other. Cryptocurrency prices vary according to changes in demand and supply.

Several policymakers, such as the ECB, the International Monetary Fund (IMF), and the Bank of International Settlement (BIS), provide similar definitions of cryptocurrencies, thus enabling us to conclude that they are: (i) intended to constitute a peer-to-peer (“P2P”) alternative to government-issued legal tender, (ii) independent of any central bank, (iii) secured by a mechanism known as cryptography, as shown in Figure 1.

[Please insert Figure 1 about here]

The nature of cryptocurrencies is a subject of debate, with national views varying widely. Table 1 reports the historical regulation in and tax principles of various countries around the world from a qualitative analysis of the literature and reports concerning cryptocurrency regulation (e.g., (Dewey, 2019), (Houben and Snyers, 2018), (Shirakawa and Korwatanasakul, 2019), and (Library of Congress, 2018)).

That lack of agreement over the very nature of cryptocurrencies results from some countries treating them as assets or commodities, while others consider them to be a means of payment or currencies (Ammous, 2018). However, most governments and even the academic literature consider them to be property, not currency (Yermack, 2015).

For instance, due to its high mean-variance profile, Bitcoin appears to be similar to common stocks. It can be argued that holding a Bitcoin is equivalent to owning part of the blockchain technology, which is an intangible asset. Moreover, the human capital is represented by qualified experts who run codes and use mathematical procedures for the sake of enhancing the system credibility. Therefore, Bitcoin could be seen as an investment generating benefits in a similar manner as common stocks (Alfieri et al., 2019), (Baur et al., 2016), (Glaser et al., 2014).

In addition to cryptocurrencies themselves, tokens are created, most notably to raise funds for new projects through a process called Initial Coin Offering (ICO). An organization with a business project can issue tokens against currencies to raise cryptocurrency funds. Token owners can then either trade them against other cryptocurrencies on a secondary market or use them within a project (e.g., voting power).

In this article, we consider cryptocurrency in general, including tokens.

[Please insert Table 1 about here]

2.2. Why regulate cryptocurrencies?

The emergence of cryptocurrencies has been a growing field of attention for scholars and professional investors. Those groups have debated the legal nature of cryptocurrencies, but there is consensus over the need to regulate the market. Despite that consensus, legislators and policymakers have been slow to act, as they need to understand fully the technical aspects before being able to develop appropriate regulatory frameworks.

The various ways of regulating cryptocurrencies can be divided based on three main objectives, which do not differ that much from those of financial assets and services regulations.

The first and main goal of regulation is to counteract risks. The high volatility of cryptocurrency markets highlights the importance of regulations in achieving financial stability (Corbet et al., 2020). According to the ECB, price stability is one of the most important objectives behind regulating the cryptocurrency market, for two main reasons: the impact of cryptocurrencies on the velocity of money, and the increasing interest in blockchain technology as a speculative tool for investing and achieving high returns in the short term. Moreover, several financial and government reports (e.g., the FSB and G20) and academic articles (e.g., (Auer and Claessens, 2018)) examine liquidity risk. They suggest that several factors can make this market illiquid, thus limiting the ability of participants to buy or sell crypto assets. Therefore, one of the objectives behind regulating this market is to make it more liquid.

The second regulatory objective is to restrict illicit activities and money laundering transactions, and protect consumers. The ECB considers that the legal uncertainty regarding cryptocurrency transactions could represent a challenge for public authorities, as such transactions can be used by criminals and money launderers in their illegal activities. Moreover, the European Union adopted Directive (EU) 2015/849, known as the 5th Anti-Money Laundering Directive (AMLD5), in 2015 with the aim of decreasing the use of financial systems for illicit purposes and terrorist financing. According to the European Commission's Vice President, Valdis Dombrovskis, "less anonymity and more traceability,

through better customer identification could help governments to better control these transactions.”

The third objective is to generate significant government revenues by implementing appropriate laws and taxes. According to Demertzis and Wolf (2018), the average daily revenues from mining new cryptocurrencies in 2018 was over USD 44 million, with more than 1.6 million unique users participating in transactions each day. As no international agreement has been reached over the unique classification of cryptocurrencies, national regulators and public authorities face various challenging problems and difficulties in treating and regulating the crypto market. Indeed, although regulating and taxing that market is an intrinsically difficult process, it could generate millions of dollars for governments.

Although countries in different regions follow the same accounting standards (e.g., GAAP⁴), that does not necessarily mean that they would enact the same cryptocurrency market regulations. Therefore, we can expect variations in how such regulations are implemented in different countries. A challenging question is to what extent such rules and legal actions could be effective in the absence of countries agreeing and adhering to a unified regulatory approach.

For instance, despite global recognition of the need to regulate cryptocurrencies, no consensus has been reached regarding even how to classify them. Until such time as governments can agree to a harmonized approach, each will unilaterally decide how to define, regulate, and manage cryptocurrencies. Table 1 summarizes cryptocurrency classification and regulation in various countries. That table adds a complementary view to the existing literature by summarizing the historical country-specific regulation and tax principles around the world. To gather that reported information, we conducted a qualitative analysis of various reports on cryptocurrency regulation.

As mentioned above, the cryptocurrency market is a sensitive one. Despite the varying national classifications of the nature of cryptocurrencies (e.g., asset or currency), we consider that adopting a national regulation for this market in any given country would increase the possibility of a regulation being adopted in another country.

⁴ The Generally Accepted Accounting Principles (GAAP) are the US accounting rules, principles, and standards issued by the Financial Accounting Standards Board.

3. Market Reaction to News

The cryptocurrency market is sensitive to news, as evidenced by numerous events in recent years. For instance, when China officially blocked all electronic websites related to cryptocurrencies in February 2018, it led to a 16 percent drop in the price of Bitcoin for 24 hours. For that reason, we consider in this article the types of events and news that might increase the probability of regulations being adopted. We consider two such classification types in this article. The first type consists of events that have already happened and regulation projects that have already been implemented. The second type consists of events, or event announcements, regarding future implementation. For both types, we consider that those events increase the probability of regulation being adopted across all countries interested in regulating the cryptocurrency market. To clarify our two-type classification, we present below two examples of real events.

First type. January 30, 2018: Since that date, South Korea has only allowed trades in cryptocurrencies from “real-name account systems,” with new rules introduced for cryptocurrency dealers (required to have a bank contract, check trader’s identity, and register the account), for traders (required to have an account at the same bank as the dealer; if traders are anonymous, they only can withdraw, not deposit), and for banks (required to analyze dealers’ management and cybersecurity, and check the trader’s identity). These rules are not allowed for foreigners and miners.

Second type. July 5, 2016: A proposal to amend the 4th Anti-Money Laundering Directive was presented in the European Commission. One aspect of that proposal was that virtual currency exchange platforms be included within the scope of the AMLD, as that would require such platforms to comply with customer due diligence requirements and implement procedures for managing (detecting, preventing, and reporting suspected) money laundering and terrorist financing. AMLD5 entered into force on July 9, 2018.

As previously mentioned, two scenarios exist for investor reactions. Under the first, the adoption of a regulation aimed at improving and stabilizing market functioning would generate positive reactions from investors who consider that it would correct market failures. In that case, investor demand for cryptocurrencies would increase, thus resulting in higher market prices for such assets. Under the second scenario, implementation of the regulation may decrease the number of investors, especially those motivated by decentralization and the

absence of regulations. Therefore, adding additional regulations would decrease such investors' interest in the market, in which case cryptocurrency demand would drop, thus resulting in lower prices for such assets. We can also foresee a situation where those two scenarios occur simultaneously. In that case, the global effect would depend on the strongest scenario, as presented in Figure 2.

[Please insert Figure 2 about here]

Based on previous literature, Auer and Claessens (2018) assess the intraday impact of regulatory news and events on the price of Bitcoin. Furthermore, by addressing the impact on other cryptocurrencies, those authors find that regulatory actions and related events have a negative impact on cryptocurrency prices. They also find a strong negative effect of news relating to cryptocurrency treatment under securities laws. A recent Koenraadt and Leung (2019) study of the impact of regulatory news finds that investors react negatively to such events. In light of that finding, we hypothesize that investors globally perceive events that increase the probability of regulation adoption to be “bad” news, thus pushing down the price of the corresponding cryptocurrency.

We formalize our hypothesis as follows:

H₁. Events that increase the probability of regulation adoption are associated with negative abnormal returns.

In the second part of our article, we formulate the following question: Is market reaction to regulatory news the same for all cryptocurrencies? We argue that the magnitude of the return reactions will not be the same across all cryptocurrencies and that some cryptocurrencies' characteristics may mitigate or amplify investor reactions. Our contribution is to analyze precisely which cryptocurrency characteristics could explain variations in investor reactions to regulation adoption. With that purpose, we consider three groups of characteristics which might cause different reactions to regulatory events. Given that improving market stability and quality are the main objectives behind regulations, we consider various financial market quality variables in the first group - mainly liquidity variables and information asymmetry measures. We consider that investors will react better to events related to a highly illiquid cryptocurrency with high information asymmetry. Following **H₁**, as a negative reaction is expected, the reaction could be mitigated and less negative for an illiquid cryptocurrency with high information asymmetry than for other

cryptocurrencies with better liquidity and lower information asymmetry. Investors would consider that such an event could improve the market quality and thus reduce information asymmetry and increase liquidity. We formalize our hypothesis as follows:

H2. Cryptocurrency characteristics of market quality (illiquidity, information asymmetry) can mitigate cryptocurrency return reactions to events that increase the probability of regulation adoption.

Cryptocurrencies also have specific intrinsic characteristics. Of those, we find it informative to study privacy and tokens. The second group is the privacy measure, which considers whether the users and/or the database are anonymous and user privacy is respected. The privacy issue is often a point of criticism in the field of cryptocurrencies, and it is mentioned in regulatory events. We consider that if a cryptocurrency is “private,” investor reaction to regulation events will be more negative, as such investors are interested in private cryptocurrencies for reasons of anonymity and privacy (Lee, 2019). We suggest the following hypothesis:

H3. Privacy measures may amplify the cryptocurrency return reactions to events that increase the probability of regulation adoption.

Finally, the third group of variables considers whether the coin is a token, especially as coins and tokens do not have the same implications on this market. Tokens are generally part of project fundraising (ICOs) and have been recently studied by governments and institutions. We consider that investors who participate in a fundraising project and hold tokens will perceive regulation as an improvement for them. Estimates of ICO fraud in the tokens market range from 10% (Tiwari et al., 2019) to 80% (Liebau and Schueffel, 2019). Investors take on that specific risk when they invest in such projects. If the market is more regulated regarding tokens and ICO processes, investors will get an additional project quality guarantee and enjoy reduced fraud risks. We suggest the following hypothesis:

H4. Token characteristic may mitigate the cryptocurrency return reactions to events that increase the probability of regulation adoption.

In the upcoming sections, we discuss these variables in detail.

4. Data and Research Methodology

4.1. Data

We obtain daily cryptocurrency data from the CoinMarketCap website, which is widely used in the existing literature (e.g., (Bouri et al., 2019), (Cheah and Fry, 2015), (Fry and Cheah, 2016)). That website allows us to extract data on opening and closing prices, trading volume, and market capitalization. To conduct our study, our chosen sample consists of the top thirty cryptocurrencies in terms of market capitalization based on the market situation as at July 4, 2019. Please see Table 2 for more detailed information. We selected the period from 2015 to 2019 for our sample as it provides the most recent significant period for which the full temporal effects of events have become clear. To select the set of news and events, we review all available reports concerning cryptocurrency market regulation. Furthermore, we make use of the FACTIVE database with specific word searches by year related to crypto market regulations, such as: “cryptocurrency regulation”, “blockchain regulation”, “tax cryptocurrency” and “regulatory cryptocurrency.” From the results of those FACTIVE searches (about 350 results), we noticed that a large number were news items concerning the themes and keywords mentioned above. We cross-referenced the FACTIVE-generated information with official reports from other sources to obtain a sample of 63 events⁵.

[Please insert Table 2 about here]

4.2. Research methodology

Event Study

We adopt a variety of approaches to achieve our objective of studying investor perceptions of regulation adoption. Historically, the event study methodology has been used in stock market studies to assess stock price reactions to important news (MacKinlay, 1997). Our main goal in this part of the study is to assess investor perceptions relating to new cryptocurrency market regulation. We examine 30 cryptocurrencies return reactions to 63 regulatory events.

⁵ The number of selected events is subject to data availability. We are aware that other studies consider a wider set of events. However, we performed our analyses first on a set of 63 events, then identified events in countries that consider the crypto market as subject to securities laws (22 events). Both samples gave similar results. Therefore, the difference in the number of events in our study and in other studies is not a point of concern.

The event window. Similar to Armstrong et al. (2010) and Zhang (2007), we conduct our study around the dates of regulation events. We use a three-day event window and, for each cryptocurrency, we calculate its return centered on the event date. For each such date, we calculate the Raw Return, which is the three-day value-weighted return for the 30 cryptocurrencies centered on the event date.

The abnormal return. Armstrong et al. (2010) and Campbell et al. (1997) use market-adjusted returns to alleviate the confounding effects of global news occurring around event dates. They choose a market index that does not take into consideration those companies that are subject to the regulation (Dow Jones ex Europe). However, as cryptocurrency regulation becomes more widespread, all cryptocurrencies are potentially subject to regulation. Therefore, we cannot use a cryptocurrency index such as the CRIX for calculating abnormal returns, because that index will itself be affected by the regulation. To manage that issue, we follow the literature on Event Studies (e.g., (Boehmer et al., 1991), (Civitarese et al., 2018), (Corrado, 1989), and (Serra, 2002)) to calculate the normal return as the average return on an estimation window prior to the event date period (to exclude possible events that might influence the returns), called the Past Average Return. Figure 3 presents the window considered.

[Please insert Figure 3 about here]

Cross-sectional analysis

The second part of our study focuses on testing whether some cryptocurrency characteristics can explain the cross-sectional variation in market reactions to regulation events. We precisely analyze whether their different characteristics give rise to variations in how cryptocurrencies react. To achieve that purpose, we estimate the following equation by using a Fama–MacBeth regression methodology. We conduct cross-sectional regression for each event date e and where j denotes cryptocurrency:

$$CMAR_{j,e} = \beta_0 + \beta_1 CET_{j,e} + \beta_2 ILIQ_{j,e} + \beta_3 MLI_{j,e} + \beta_4 Delay_{j,e} + \beta_5 Size_{j,e} + \beta_6 Vol_{j,e} + \beta_7 PRI_{j,e} + \beta_8 TOK_{j,e} + \epsilon_{j,e} \quad (1)$$

where CMAR is the cryptocurrency's cumulative market-adjusted return, measured as the three-day return centered on the event date minus the average return using an estimation window before the event date (-120 days to -5 days) (Civitarese et al., 2018).

The independent variables are the cryptocurrencies' characteristics. We consider the Coefficient of Elasticity of Trading (CET), the Amihud (2002) illiquidity measure (ILIQ), the Index of Martin (MLI), the Price Delay (Delay), the Size (Size), the Trading Volume (Vol), the Privacy (PRI), and the Token (TOK) variables. Based on the regulators' objective or the possible impact of regulations on those variables, they enable us to appraise the three types of characteristics previously presented (i.e., (i) market quality, (ii) privacy, and (iii) token).

The first group (CET, ILIQ, MLI, Delay, Size, and Vol) consists of financial market quality variables (mainly liquidity variables and an information asymmetry measure), the increase of which has been a major objective of several regulatory events. As the cryptocurrency market faces liquidity issues (Dyhrberg et al., (2018), Weil (2018)), we consider liquidity measures. Given the link between liquidity and information asymmetries, we also include in our analysis a notable measure, the Price Delay (Delay) of Hou and Moskowitz (2005), to measure the delay in information being incorporated into prices.

The second group (PRI) is the privacy measure, which is a variable we created to assess whether the users and/or the database are anonymous and user privacy is respected. The cryptocurrency transparency aspect raises several regulatory questions regarding user and exchange privacy, especially when dealing with illicit markets.

Finally, the third group, tokens (TOK), is a dummy variable equaling 1 if the cryptocurrency is considered a token, or 0 if not. Tokens are generally used in cryptocurrency fundraising and pose questions regarding the reliability of projects for investors. Therefore, some recent regulation events discussing the regulation of such projects might have an impact on tokens.

Group 1: Financial market quality variables

Our model includes three proxies of market liquidity. It is well known that liquidity describes how quickly an asset can be purchased in non-negligible quantities without having an impact on its market price. Of the several methodologies for measuring asset liquidity provided by the literature, we select three of the more popular approaches to use in our study. Those three liquidity measures are discussed below:

Coefficient of Elasticity of Trading (CET)

This measure was first proposed by Datar (2000), who considers liquidity to be similar to the price elasticity of trading volume. The coefficient of elasticity measure (CET) is calculated by dividing the percentage change in trading volume by the percentage change in price.

$$CET = \frac{\% \text{ of the change in Trading Volume}}{\% \text{ change in Price}} = \sum_{t=1}^T \frac{\ln(\frac{V_t}{V_{t-1}})}{\ln(\frac{P_t}{P_{t-1}})} \quad (2)$$

The range of CET is from negative infinity to positive infinity. According to Datar (2000), a stock is highly liquid if its CET value is far away from zero; either approaching positive or negative infinity. A high value of CET means the price changes are accompanied by a large change in transaction volume (Loi, 2018).

Amihud (2002) illiquidity ratio

This illiquidity measure has been widely used in the literature. According to Amihud (2002), the lower the asset liquidity, the higher the expected return yield. Amihud's proxy is given by the absolute daily stock returns divided by trading volumes.

$$ILLIQ_{it} = |R_{it}| / V_{it} P_{it} \quad (3)$$

where $|R_{it}|$ is the absolute value of the daily return on cryptocurrency i on day t ; V_{it} is the daily traded volume, and P_{it} is the closing price of cryptocurrency i on day t .

Martin (1975) index

This measure was proposed by Martin (1975). A high liquidity index (MLI) value indicates less liquidity in a cryptocurrency. The index takes into consideration price changes throughout the entire transaction time.

$$MLI = \sum_{t=1}^T (P_t - P_{t-1})^2 / V_t \quad (4)$$

where P_t is the closing price on day t and V_t is the daily traded volume on day t .

Price Delay Measure

Given the link between liquidity and information asymmetries, we include in our model the Hou and Moskowitz (2005) Price Delay measure. Fama (1970) considers that, in an efficient market, prices should incorporate new information without any delay. This proxy evaluates that process of incorporating information into prices, with the higher the Price Delay, the lower the price informativeness. Hou and Moskowitz (2005) consider several measures for capturing the average delay with which a company’s stock price responds to information. The market return is considered relevant news to which stocks react and is thus incorporated into their prices. We consider the “D1” measure. The incorporation of information into prices for our cryptocurrency sample is supposed to occur at the daily level. To better detect that process, we calculate the Hou and Moskowitz (2005) Price Delay measure with daily returns (instead of weekly returns⁶). To calculate our delay measure, we select the CRIX index as a market index. The CRIX Index⁷ is a monthly rebalanced capitalization-weighted index including a dynamic number of constituents eligible under liquidity and market-capitalization ranking rules (Trimborn and Härdle, 2016). We perform the following time-series regressions:

$$r_{j,t} = \alpha_j + \beta_j R_{m,t} + \epsilon_{j,t} \quad (5)$$

$$r_{j,t} = \alpha_j + \beta_j R_{m,t} + \sum_{n=1}^4 \delta_j^{(-n)} R_{m,t-n} + \epsilon_{j,t} \quad (6)$$

$$D1 = 1 - \frac{R^2(Eq5)}{R^2(Eq6)} \quad (7)$$

where r_{jt} is the return on cryptocurrency j at time t and $R_{m,t}$ is the return on the CRIX value-weighted market index on day t . D1 equals one minus the ratio between the R^2 from regression (5) and the R^2 from regression (6) which considers that the stock return is explained not only by the contemporaneous returns of the market portfolio but also its four date-lagged returns. For calculating cryptocurrency i ’s D1 measure on day t , we perform regressions (5) and (6) over a 60-day period before day t . We then calculate the ratio of the two R^2 regressions and subtract it from one.

⁶ Hou and Moskowitz (2005) calculate the D1 measure with weekly returns. They justify their choice by mentioning that they “focus on stocks with the most severe delay (frictions), whose lagged response often takes several weeks.”

⁷ <https://thecrix.de/>

Size and Trading Volume

Size is the natural log of each cryptocurrency's market capitalization. The trading volume is the amount of coin traded in the previous 24 hours according to the CoinMarketCap website.

Group 2: Privacy measure

Privacy coins are cryptocurrencies that hide data about their users; basically, the user's identity along with the amount of cryptocurrency traded and held in their wallet. In general, privacy indicates whether the users and/or the database are anonymous and user privacy is respected. The number of coins owned, sent, or received is not observable, traceable, nor linkable by way of blockchain transaction history. This variable is controlled using a dummy variable taking the value of 0 if the transaction is not private, or 1 if it is private. If a cryptocurrency offers a mixed approach, we code it as private. For example, Dash offers the option of hiding transactions in a single transaction and distributing the coins to a new address through a series of random nodes (PrivateSend).

Group 3: Tokens

We include tokens in the 30 cryptocurrencies used in our study. Tokens are generally created and issued as a fund-raising effort (such as ICOs) for a new project. Tokens are generally issued and backed using existing blockchains (e.g., ERC20 tokens are issued using the Ethereum blockchain), and sold against famous cryptocurrencies (generally Bitcoin or Ether). Investors buy those tokens, which they can then sell on a secondary market (against traditional currencies) or keep for use in the project. Various types of token exist: investment tokens (security tokens) whose purpose is to realize a capital gain and those allowing access to a project service or product (utility tokens).

It is possible that regulation events have more impact on the cryptocurrency market when tokens are involved, especially given the growth of ICOs and the regulation of tokens. Table 1 presents some notable ICO regulations by region. For example, since the introduction of France's new action plan for business growth and transformation regulation (PACTE law) in May 2019, ICO issuers have had the option of applying for a visa from the Financial Markets Authorities (AMF), the country's stock market regulator. Such visas confer both recognition

of reliability and protection for investors and issuers. To assist potential investors to avoid potential scam ICO projects, the AMF also publishes a “blacklist” of ICOs.

TOK is a dummy variable where the variable is equal to 1 if the coin is a token and equal to 0 otherwise.

Performance model

The first two steps in the method mainly focus on the short-term impact of regulation on cryptocurrency returns. This subsection deals with how regulatory events have affected the performance of cryptocurrencies across a longer time horizon. The objective is to analyze the market equilibrium impact across a longer time frame than that of the short-term effects assessed by the event study. Therefore, we calculate cryptocurrencies’ long-term performances using traditional performance measures noted in the literature. We focus on the performance of a cryptocurrency portfolio composed of seven major cryptocurrencies: Bitcoin (BTC), Ether (ETH), Litecoin (LTC), Tether (USDT), Ripple (XRP), Dash (DASH), and Monero (XMR).

The first measure we consider is the Sharpe Ratio, which adjusts excess returns for total (systematic and diversifiable) risk.

$$\text{Sharpe Ratio} = \frac{(R_p - R_f)}{\sigma_p} \quad (7)$$

where R_p and σ_p are the return and the standard deviation, respectively, of the cryptocurrency portfolio, with R_f as the risk-free rate considered as the one-month US Treasury Bill return.

The second measure is Jensen’s alpha based on the CAPM model.

$$R_{p,t} - R_{f,t} = \alpha + \beta * (R_{m,t} - R_{f,t}) + \varepsilon_t \quad (8)$$

where $R_{p,t}$ is the cryptocurrency portfolio return during period t, $(R_{m,t} - R_{f,t})$ is the return of the market’s portfolio proxy exceeding the risk-free rate, and ε_t is the error term.

Third, we estimate the cryptocurrency performance using the Fama and French (1992) three-factor model.

$$R_{p,t} - R_{f,t} = \alpha + \beta_1 * (R_{m,t} - R_{f,t}) + \beta_2 * SMB_t + \beta_3 * HML_t + \varepsilon_t \quad (9)$$

where $R_{p,t}$ is the cryptocurrency portfolio return during period t , $(R_{m,t} - R_{f,t})$ is the return of the market's portfolio proxy exceeding the risk-free rate, SMB (Small Minus Big) and HML (High Minus Low) are the returns of the zero-investment factor-mimicking portfolios for size and book-to-market (B/M) equity as proposed by (Fama and French, 1992), and ε_t is the error term.

Fourth, we estimate the Carhart four-factor model adding the momentum factor, Winner Minus Loser (WML) (Carhart, 1997).

$$R_{p,t} - R_{f,t} = \alpha + \beta_1 * (R_{m,t} - R_{f,t}) + \beta_2 * SMB_t + \beta_3 * HML_t + \beta_4 * WLM_t + \varepsilon_t \quad (10)$$

where $R_{p,t}$ is the cryptocurrency portfolio return during period t , $(R_{m,t} - R_{f,t})$ is the return of the market's portfolio proxy exceeding the risk-free rate, SMB (Small Minus Big) and HML (High Minus Low) are the returns of the zero-investment factor-mimicking portfolios for size and book-to-market (B/M) equity as proposed by (Fama and French, 1992), WML is the momentum factor as suggested by (Cahart, 1997), and ε_t is the error term.

As mentioned, our objective is to analyze the impact of regulation events on the cryptocurrency market in the long run. Therefore, we choose one period before the events (pre-period) and one period after the events (post-period) in order to analyze the performance before and after regulation events.

Our entire regulatory events sample covers the period from 2015 to 2019. Figure 4 shows the concentration of our sample events with respect to time. We find the most concentrated period of events to be from June 26, 2017 to October 19, 2018.

[Please insert Figure 4 about here]

The pre-period is drawn from June 24, 2016 to June 24, 2017, with the post-period drawn from October 21, 2018 to October 21, 2019. We delineate the pre-period to end two days before June 26, 2017, to avoid capturing the regulatory events concentration period and for calculating the three-day market-adjusted return. For the same reasons, we delineate the post-period to start two days after October 19, 2018 (see Figure 5). As a robustness test, we extend

the study to the longest historical period possible (e.g., 437 days instead of 366) to maintain our seven cryptocurrencies in our portfolio. Indeed, those cryptocurrencies were not all created on the same date, but we aim to keep the same components in our portfolio to provide a reliable comparison between the two periods.

[Please insert Figure 5 about here]

First, Jensen's alpha is estimated using a cryptocurrency index, the CRIX, as a market portfolio proxy, R_m . Second, since we have shown that cryptocurrencies can be considered as securities, we use international global factors from the Kenneth R. French website (Fama and French, 2012) that are normally used in the stock market for the R_m , SMB, HML (Fama-French model), and WML (Carhart model). The risk-free-rate, R_f , of the above models is the one-month US Treasury Bill return.

Furthermore, consistent with the most up-to-date empirical literature, we employ the Newey and West (1987) adjusted standard errors of estimates to alleviate concerns regarding possible autocorrelation and heteroscedasticity.

5. Empirical Results

5.1. Market Reaction results

In this section, we first analyze investor reactions to news which increases the probability of regulation adoption. We look at their first reaction and how they consider the implementation of laws or regulations that would make the market more stable. Table 3 presents the event return statistics. As mentioned above, we follow the approach of Campbell et al. (1997) and Armstrong et al. (2010). In the first column (raw returns), we present the cryptocurrency returns for each of the 63 events, for which we calculate the three-day value-weighted return centered on the event date. To mitigate the compounding effects of global news occurring concurrently with our event dates, we calculate the cryptocurrencies' average returns using an estimation window before the event date, thereby excluding possible events that might influence the returns (second column of Table 3).

The third column presents the difference between the raw return and the Past Average Return period, which is the observed abnormal return, also known as the "adjusted raw

return.” The results show that the mean raw return corresponding to the 63 events is 0.00313 ** and is 0.01754 ** for the Past Average Return. The difference, which is the adjusted raw return, is -0.01461^{**} , which is negative and significantly different from zero, as confirmed by the t-test.

The adjusted raw return’s negative result indicates that investors have globally considered the events to be bad news and that the costs of regulation adoption would be higher than its benefits. This is consistent with our first hypothesis H1, which indicates a negative relationship between events related to regulation and cryptocurrency returns.

[Please insert Table 3 about here]

Market reaction to events that treat cryptocurrencies under securities laws (22 events)

We further investigated and tried to isolate the events that would see cryptocurrencies treated under securities law. The events that we consider are of a type that increase the probability of regulation adoption. We particularly emphasize events in countries that consider the crypto market to be subject to securities laws. An example of such an event occurred on July 26, 2017, when the SEC considered ICO tokens as securities and thus subject to securities laws. Our results show that the overall reaction was negative, with an adverse and more significant relationship.

Table 4 shows that the mean raw return corresponding to the 22 events is -0.01577^{***} and is 0.01754 *** for the Past Average Return. The difference, which is the adjusted raw return, is -0.03331^{***} , which is negative and more significantly different from zero, as confirmed by the t-test.

[Please insert Table 4 about here]

5.2. Cross-Sectional results

This section presents the cross-sectional results in detail. Table 5 presents the descriptive statistics for the variables used in our model. Table 6 presents the Pearson correlation coefficients between the variables. It is clear from the table that CMAR is significantly correlated with the majority of the variables.

[Please insert Table 5 about here]

[Please insert Table 6 about here]

Table 7 presents Fama-Macbeth regression summary statistics from Equation 1. Column (1) presents the results obtained from regressing CMAR over the cryptocurrency characteristics (CET, ILIQ, MLI, Delay, Size, VOL, PRI, and TOK). Those results reveal that the CET is negative and significantly (at least at the 10 percent level) related to the dependent variable CMAR. That therefore indicates that CMAR is less negative when the cryptocurrency is more illiquid. In other words, investors reacted less negatively to illiquid cryptocurrencies. As one of the objectives of regulation is to increase cryptocurrency market liquidity, those results could be explained by the fact that even though the investors reacted negatively to such regulations, the reaction was less negative for illiquid cryptocurrencies. Thus, investors might consider that the regulation is capable of achieving the established goals.

Table 7 also shows that the Price Delay (Delay) measure is positive and significantly (at least at the 10 percent level) related to the dependent variable CMAR. That therefore indicates that CMAR is less negative when Price Delay is larger (i.e., when there is more information asymmetry), and investors react differently regarding cryptocurrencies with a high level of price delay (i.e., cryptocurrencies for which the information took more time to be incorporated into prices). For such cryptocurrencies, investors consider the regulation as a way of increasing price efficiency and thus perceive it more positively.

Moreover, regression from Equation 1 shows that the size of cryptocurrencies is negative and significantly (at least at the 10 percent level) related to the dependent variable CMAR. That therefore indicates that CMAR is less negative for companies with low market capitalization. That could be explained by the fact that such cryptocurrencies are less known, thus resulting in less information being disseminated about them.

[Please insert Table 7 about here]

5.3. Long-term performance results

Figure 6 presents the closing prices of the cryptocurrencies used in the portfolio: Bitcoin (BTC), Ether (ETH), Litecoin (LTC), Tether (USDT), Ripple (XRP), Dash (DASH), and Monero (XMR). Since Bitcoin records much higher closing prices than its peers, we cannot

clearly visualize the price movement of the other cryptocurrencies in Figure 6. To address that inconvenience, Figure 7 provides the cryptocurrency price variation without including Bitcoin. The red area presents the pre- and post-periods observed in our analysis.

[Please insert Figure 6 about here]

[Please insert Figure 7 about here]

Table 8 and 9 present the descriptive statistics for the performance model variables and for the Pearson correlation coefficients, respectively. The latter shows that all but CRIX in the cryptocurrency portfolio have a low correlation with those portfolios.

[Please insert Table 8 about here]

[Please insert Table 9 about here]

Table 10 presents the results of the performance regression analyses. During the pre-period, we obtain a positive and significant alpha with an annualized value of 178 percent for Jensen's alpha using the CRIX factor. The CRIX coefficient is significant and positive. We obtain an annualized alpha of 961.13 percent when we use the stock market R_m from the Kenneth R. French website. The Fama-French and Carhart models also provide positive and significant alphas of 974.92 percent, and 973.98 percent, respectively. The Sharpe ratio is also positive (0.22) during this period. However, during the post-period of our sample of regulatory events, we find a negative performance using the Sharpe ratio (-0.022) and a non-significant performance with the alpha performance models.

[Please insert Table 10 about here]

Our results are robust when we estimate the above regressions for longer pre- and post-periods (437 days instead of 366). For further details, see Table 11 and Table 12. When we increase the size of our subsamples (pre- and post-periods), we obtain a positive and significant alpha of 143.13 percent for Jensen's model using the CRIX factor as a market factor. Moreover, when we use the stock market factor of Fama-French to calculate Jensen's alpha, we obtain an alpha of 801.65 percent. The Fama-French and Carhart models also provide positive and significant alphas of 837.34 percent and 833.95 percent, respectively. The alpha results are all positive and significant but with a lower value than in the shortest pre-period. During the post-period, all the alphas are also not significant.

[Please insert Table 11 about here]

[Please insert Table 12 about here]

[Please insert Table 13 about here]

6. Discussion

Our primary purpose in this study was to capture through an event study investors' reactions to events and actions that increase the probability of regulation adoption. We aimed to assess how investors receive such events and whether they consider them to be “good” or “bad” news. According to H1, we expected events that increase the probability of the adoption of regulations to be associated with a negative abnormal return. Our results show that investors reacted negatively to the possible adoption of regulations and that they considered such events to be “bad” news. Those results may be explained in several ways, including that many investors may have been motivated to enter the market mainly because it is a non-regulated market and the absence of additional transaction costs. Moreover, legislator and policymaker actions remain weak due to their need to understand the technical aspects before being able to develop and implement regulation. It is possible that such factors have led investors to distrust financial regulators. In further investigating and trying to isolate the events in our study that treated cryptocurrencies under securities law, we found that the reaction was worse, with an adverse and more significant relationship. That conclusion is consistent with literature findings such as those of Auer and Claessens (2018) and Koenraadt and Leung (2019) which show that regulation would have a negative impact on cryptocurrency returns.

In the second part of our article, we tried to examine whether the various intrinsic characteristics of cryptocurrencies influenced changes in their value due to regulation news. We implemented an empirical model while considering microstructure variables widely used in the existing literature, such as the Amihud (2002) illiquidity measure, the Coefficient of Elasticity of Trading, and the Hou and Moskowitz (2005) delay measure. As mentioned in H2, cryptocurrency characteristics of market quality (illiquidity, information asymmetry) are expected to mitigate cryptocurrency return reactions to events which increase the probability of regulation adoption. We found that investors reacted less negatively for most illiquid cryptocurrencies and for cryptocurrencies that had more information asymmetry, as measured

by the process of information incorporation into prices. As one of the objectives of regulation is to increase cryptocurrency market liquidity, those results could be explained by the fact that, although investors reacted globally negatively to those regulations, the reaction was less negative for illiquid cryptocurrencies. Regarding the specific intrinsic characteristics, we expected that privacy may amplify and tokens may mitigate the cryptocurrency return reactions to events which increase the probability of regulation adoption (e.g., H3 and H4). Our results show that both coefficients are insignificant. The fact that a crypto is private or a token does not affect the investor reactions to regulatory events.

To assess the impact of regulation on the longer-term performance of a cryptocurrency portfolio composed of major cryptocurrencies (Bitcoin (BTC), Ether (ETH), Litecoin (LTC), Tether (USDT), Ripple (XRP), Dash (DASH), and Monero (XMR)), we calculated cryptocurrencies' long-term performances using traditional performance measures well-known in the literature. After measuring a positive and significant performance in the pre-event period, we find a non-significant performance in the post-event period. The alpha measure estimates the adjusted return taking into consideration the risk premium associated with various factors. We consider known risk premiums in the stock market, such as the market risk premium, the size, the book-to-market, and the momentum effects, but there might be other risk premiums specific to cryptocurrencies that are not present in the examined models. That would explain why in the pre-period we have a positive and significant alpha which remunerates risks that are not included in the model, such as the liquidity risk and information asymmetry risk. In the post-event period, such risks might no longer exist and might no longer be remunerated, thus making alpha insignificant. The events have therefore potentially mitigated perceptions of those risks.

7. Conclusion

Since its creation, the cryptocurrency market initiated with Bitcoin has been a subject of debate within financial institutions and attracted the particular interest of scholars. That more than 5,000 cryptocurrencies have been created to date indicates the rapid development of this market. Over recent years, financial regulators and governments have sought to control the market for several reasons. First, several reports emphasize a possible liquidity issue in the market, with several factors potentially responsible for making the market illiquid. Such

issues limit the ability of participants to buy or sell crypto assets. Second, the increasing interest in blockchain technology as a speculative tool for investing and achieving high returns in the short term was one of the most important reasons for seeking to stabilize the market and reduce the related risks, particularly for investors. Third, regulations enable the generation of significant revenues from new sources, whether from taxes or as a result of new laws.

The results in the first part of this study show that investors reacted negatively to the possible adoption of regulations regarding the cryptocurrency market and that they considered such events to be “bad” news. Moreover, we found that some specific cryptocurrencies react differently due to specific market quality characteristics. Our results show that investors reacted less negatively for most illiquid cryptocurrencies and for cryptocurrencies that had more information asymmetry. In the second part, the objective was to analyze the longer-term impact of regulation on the risk-adjusted returns of a cryptocurrency portfolio of major cryptocurrencies. After measuring a positive and significant performance in the pre-event period, we find a non-significant performance in the post-event period.

To conclude, our results confirmed our expectations that regulatory events have a negative impact on cryptocurrency stock returns, both in the short and longer term, because this market was established in a decentralized manner, away from the supervision of any government or regulating institutions. Indeed, the market attracted investors for those reasons. The results on performance measures are not surprising if we consider that a lower risk exposure would result in a lower return. Indeed, that could lead to an insignificant impact on the performance of cryptocurrencies.

Table 1: Historical regulation and tax principles around the World

This table presents the historical regulation and tax principles for different countries around the world, thanks to a qualitative analysis of the literature review and reports concerning cryptocurrencies' regulations (e.g. Library of Congress (2018), Dewey (2019), Shirakawa and Korwatanasakul (2019), Houben and Snyers (2018)).

Country	Legal	Historical regulation	Tax principles
North America			
USA	Yes	Commodities and Futures Trading Commission: Commodity (September 2015, 23 august 2018 (Court))	Property tax rules
		Internal Revenue Service: property (14 April 2014)	
		SEC: Tokens as security (6 February 2018)	
		FinCEN: Money (30 January 2014, 27 October 2014)	
Canada	Yes	Canada Revenue Agency: Commodity	Income Tax Act as a barter transaction
		Financial Consumer Agency: Pay goods and services as a barter transaction	Canadian Tax authorities: taxed as a commodity (intangible)
		Currency Act: No legal tender (2015)	
		Canadian Securities Administrators (CSA): Security laws (respects the Investment Contract Test) for ICO and tokens (24 August 2017)	
		Bill C-31: Money laundering and terrorist, Bitcoin as money service business (19 June 2014)	
		Project Jasper: DLT experiment	
Mexico	Yes	Law to Regulate Financial Technology Companies: Mean of payment and investment (28 march 2018)	Not clear statutory rules
		No legal tender	
South America			
Argentina	Not regulated	Bank Central: Money but no legal tender (28 May 2014)	Income tax law
		Argentine Civil Code: Intangible asset as "Good" or "Thing"	
		Financial Information Unit: Controversial money, no legal tender	

		Brazilian Federal Reserve Bank: Alters on the risk (19 February 2014)	Income tax on capital gains as "other assets" (2016)
		Bill 1 (7 July 2015): Payment schemes (prohibition discussions)	Reporting obligations to exchanges and legal entities and individuals holding cryptocurrency (May 2019)
Brazil	Not regulated	Brazilian Federal Reserve Bank: Not regulated, no legal tender, no electronic money, alert on the risks (16 November 2017)	
		Comissao de Valores Mobilizairos (CVM): Concerns about ICO (2017/2018)	
		Bill 2 (4 April 2019): Not securities but free to be issued, transferred and used	
		Central Bank: no local currency (29 September 2016)	
Colombia	Not regulated	Superintendencia Financiera: Not currency, no legal tender, not security (06 June 2017)	
		Financial institutions are not authorized to protect, invest, broker or manage cryptocurrency	
		Decree 3196: Authorization to create its cryptocurrency (Petro) backed by Venezuelan oil, financial asset, the supervisory authority of cryptocurrency creation (8 December 2017)	Not clear statutory rules
Venezuela	Yes	National assembly: Petro is illegal. Only the Central Bank can issue national currency (8 March 2018)	
		Government: Petro is legal tender (9 April 2018) Constitutional Decree on Cryptoassets and the Sovereign Cryptocurrency Petro	
		Presidential Decree N° 3.355,15 which created the Superintendence on Cryptocurrency and Connected Activities	
Europe			
		UE = means of payment (no TVA) not Commodity	Sales tax (VAT/GTS) not transposable to conversion fiat currency-bitcoin (22 October 2015)
		ECB: As virtual currencies (October 2012), convertible decentralized virtual currency (February 2015), warns about high risk (5 February 2018)	
European Union	Yes	ECB and Bank of Japan: Stella project about DLT (December 2016)	
		Financial Action Task Force: As virtual currencies, a medium of exchange and/or unit of account and/or store of value, no legal tender (June 2014)	
		EBA: As virtual currency (4 July 2014), agreed with	

European Commission about AMLD (December 2013, July 2014 and August 2016)

European Commission: Fourth Anti-money laundering Directive (AMLD), cryptocurrency as a mean of payment

Proposal (5 July 2016), Agreed and Approved by the Council (29 January 2018), Adopted by the European Parliament (19 April 2018)

ESMA: Statement on ICO (November 2017), warn to consumers

ESMA, EBA, EIOPA: As virtual currencies, no legal tender, warn about risk (12 February 2018)

FinTech Action Plan: new tech (8 March 2018), launch EU Blockchain Observatory and Forum

Banque de France: No real currency, no mean of payment, volatility and illicit activities, conversion as a payment service (5 December 2013)

Capital gain: taxation if occasional or habitual (3 February 2016)

The ordinance "Mini bons": blockchain definition (28 April 2016)

Gift tax: French wealth tax, transfer cryptocurrencies to other

AMF: Digital asset fundraising support UNICORN (October 2017)

AMF and Prudential Supervisory Authority: Notice to investors, warn about unregulation and volatility, no financial instruments (4 December 2017)

Senate: Necessity of new legal framework, reduce illicit activities, protection, and transparency for investors and promote innovation (7 February 2018)

France
In
progress

AMF: cryptocurrency derivatives, regulation of exchange related to derivative under MiFID2 (22 February 2018)

AMF: list of exchange without the requirement of AMF (15 March 2018)

Ministry of Economy and Finance: Interested in the regulation of ICO (in purpose for investors) (19 March 2018)

Ordinance blockchain authorization for more financial instruments (1 July 2018)

National Assembly: Fact-finding mission on cryptocurrency and on the blockchain (30 January 2019)

Action Plan for Growth and Transformation of Companies (PACTE law): ICO with AMF visa optional, numerical assets, protection of investors, Blacklist of ICO and

		possibility to block websites (11 April 2019)	
Germany	Yes	German Federal Financial Supervisory Authority: Unit of account and financial instruments (19 December 2013)	Transaction cryptocurrency vs fiat currency: exempt of VAT
		German Government Public warning: No legal tender, but substitute currency (2 February 2018)	Transaction as a means of payment: Not taxable for VAT
		German BaFin: Regulation of ICO as financial instruments and tokens as securities (capital investments or units or shares in investments funds) (20 February 2018)	Mining: Not taxable for VAT
		German Federal Ministry of Finance: Guidance on value-added tax (VAT) (27 February 2018)	Digital wallets services: Taxable activity for VAT Providing an exchange platform: Taxable for VAT
Ireland	Not regulated	Tourism industry IrishCoin (17 May 2014)	Normal basic principles
		Central Bank of Ireland: In cases of ICO if a token is a transferable security, then financial services legislation (20 March 2018)	
		Central Bank of Ireland: No legal tender, no regulated by the CBI, high-risk speculative asset and not currency (website)	
		Central Bank of Ireland: Alert on ICO, volatility (December 2017)	
Luxembourg	Yes	Financial Sector Monitoring Commission (CSSF): warn about risks, volatility, no protection, lack liquidity, lack transparency, fraud money laundering, risks of ICO but favorable at blockchain techno, no legal tender (14 March 2018)	If Income of cryptocurrency: commercial profit If Income is not commercial profit: other income
		Minister of Finance: Currencies, no monetary regulation (26 June 2017), Major Bitcoin trading platform fully licensed payment service in Lux (BitFLyer) (27 January 2018)	VAT exemption for CC transactions
		Circular on specific tax aspects: Not a currency and not legal tender, an intangible asset for direct tax purposes (26 July 2018)	
Spain	Yes	National Securities Commission & Bank of Spain: No legal tender and warn about risks (8 February 2018)	Profits from cryptocurrencies: Income Tax of Individuals
		Spanish law: No financial instrument, no currency, but ok for securities in ICO or chattels or commodities	Profits from bitcoin: exempt from value-added tax
Switzerland	Yes	Swiss Federal Government: As means of payment, no legal tender, not money (25 June 2014)	By individuals:
		Commercial Register Office in the Canton of Zug: Accept Bitcoin and Ether for administrative costs and as the contribution of forming a company (2 November 2017)	Wealth tax: cryptocurrencies must be converted into Swiss Franc. Considered as assets (comparable with a bank

		<p>Municipality of Chiasso, in the Swiss Canton of Ticino: Accept Bitcoin as a tax payment for amounts of up to 250CHF (1 January 2018)</p> <p>Swiss Financial Market Supervisory Authority - Guideline for ICO treatment: No regulation, payment tokens (cryptocurrencies) as mean of payment/mean of money and value transfer; utility token (digital access); asset tokens: equities, bonds, and derivatives (16 February 2018)</p> <p>FINMA: Close down unauthorized providers of e-coin (fake crypto), liquidated companies and warning about fake crypto (19 September 2017), regulatory aspects of ICO in Switzerland (29 September 2017)</p> <p>Swiss State Secretariat for International Finance: Working group of blockchain and ICO (18 January 2018)</p>	<p>deposit), subject to wealth tax</p> <p>Income tax: Exempt in general. Expect if part of business asset of an individual, Income tax</p> <p>By legal entities:</p> <p>Capital tax: Considered as cost of acquisition or converted (if lower)</p> <p>Corporate income tax: Any net taxable earnings from the sale of CC. Non-realized gains, Income tax (market to market accounting)</p> <p>VAT: legal tender</p>
			<p>Income Tax depends upon the "activities and parties involved"</p>
United-Kingdom	Yes	<p>Bank of England: Not money (Q3 2014), Financial Policy Committee, not a risk for financial stability but the risk for investors (12 March 2018), Cryptoasset Taskforce, Risks (objective of stability, regulatory framework, DLT) (29 October 2018)</p> <p>HM Revenue and Customs: No investment activity or payment mechanism (3 March 2014)</p> <p>MLD5: No legal tender, means of exchange (transposed in law 10 January 2020)</p>	<p>VAT from suppliers for goods and services transactions in the UK</p> <p>Corporate tax (profit/loss): Business with profit and loss / General rules on foreign exchange and loan relationship</p> <p>Unincorporated business: Income tax</p> <p>Cryptocurrency transaction in currency: Capital gains tax</p>
Asia			
China	Limited	<p>Notice on Precautions Against the Risks of Bitcoins (PBOC, MIIT, CBRC, CSRC, CIRC): Warn about the risks, Bitcoin as a virtual commodity, no currency, ban as currency (3 December 2013)</p> <p>Announcement on Preventing Financial Risks from ICO (7 central government regulators): Ban ICO (4 September 2017)</p>	

		<p>People's Bank of China: Study of digital currency, not a tool for retail payment (paper bills, coins or credit card) (1 March 2018)</p> <p>China Banking and Insurance Regulatory Commission (CBIRC): WP (June 2018)</p>	
Japan	Yes	<p>Guidance for a risk-based approach to virtual Currencies (FATF) (June 2015)</p> <p>Payment Services Act amended (June 2016) and effect (1 April 2017): As property value can be used as payment for goods and services, purchased, transferable, exchangeable via an electronic system</p> <p>Japan Virtual Currency Exchange Association (29 March 2018)</p>	<p>Consumption Tax (unit 1 July 2017)</p> <p>Gains: "miscellaneous income"</p>
		<p>Financial Supervisory Service: not form financial regulatory, not fiat currency, not electronic means, not financial investment instruments (23 June 2017), ban loan in cryptocurrency (1 September 2017), ban ICO that violate FSCMA (4 September 2017)</p> <p>Bank of Korea: task force on cryptocurrency (central bank-backed crypto) (9 January 2018)</p> <p>Real Name Verification System: Trades in cryptocurrencies are allowed from real-name account banks (30 January 2018)</p> <p>Supreme Court of Korea: As criminal proceeds, as property (30 May 2018)</p> <p>Korean Financial Intelligence Unit: Guidelines, money laundering</p> <p>Financial Supervisory Service: Support cryptocurrency trading and encourage institutions to facilitate the transaction (20 February 2018)</p>	National Tax Service (2017)
		Oceania	
Australia	Yes	<p>Digital Currency- Game Changer or Bit Player (August 2015)</p> <p>Committee recommendations government: tax treatment, (May 2016)</p> <p>Australian Taxation Office guidance (last update 18 June 2019)</p>	ATO rules

Table 2: Top30 Cryptocurrencies

This table presents the top thirty cryptocurrencies on the 4th July 2019 using Coinmarketcap website, used in our study and their relative names, tickers, if they are considered to be private or if they are considered as tokens.

Name	Ticker	Privacy	Token
Cardano	ADA	0	1
Cosmos	ATOM	0	0
BasicAttentionToken	BAT	1	1
Bitcoincash	BCH	0	0
Binancecoin	BNB	1	1
BitcoinSV	BSV	0	0
Bitcoin	BTC	0	0
BitcoinGold	BTG	0	0
BitTorrent	BTT	0	1
Crypto.comchain	CRO	0	1
Dash	DASH	1	0
Dogecoin	DOGE	0	0
EOS	EOS	0	1
EthereumClassic	ETC	0	0
Ether	ETH	0	0
Chainlink	LINK	0	1
Litecoin	LTC	0	0
Iota	MIOTA	0	0
Maker	MKR	0	1
Neo	NEO	0	0
Ontology	ONT	0	0
Tron	TRX	0	0
Tether	USDT	0	1
VeChain	VET	0	1
Nem	XEM	0	0
Stellar	XLM	0	0
Monero	XMR	1	0
Ripple	XRP	0	0
Tezos	XTZ	0	1
Zcash	ZEC	1	0

Table 3: Market Reaction to Events Increasing the Adoption of Regulation (63 events)

This table presents the three-day returns centered on the 63 events considered as affecting the likelihood of regulation adoption. Raw Return is the three-day return to the 30 cryptocurrencies, centered on the event date. Past Average Return is the average return using an estimation window before the event date to exclude possible events that might influence the returns. Adjusted Return is the difference between Raw Return and Past Average Return.

Date	Description	Raw Return	Past Average Return	Adjusted Return
7/7/2015	Discussions about the investment in cryptocurrencies in Brazil	0.01096	0.00006	0.01090
8/8/2015	Announcement of Bitcoin companies to stop business in New York State because of the new regulations	-0.05164	0.00381	-0.05545
3/11/2016	Russian Ministry of Finance proposes 7 years in Prison for crypto-currency use	0.01329	0.01039	0.00290
4/28/2016	First definition of the blockchain in France through the "Mini bons" ordinance	0.01740	0.00479	0.01261
7/5/2016	EU Commission's proposal to bring Virtual Currencies into the scope of Directive	-0.01606	0.00913	-0.02519
9/29/2016	Colombia Central Bank states that cryptocurrencies are not considered as local currencies	0.00492	0.00368	0.00124
3/10/2017	The SEC rejects a proposal to alter stock exchange rules to allow an ETF Bitcoin creation	0.01672	0.01102	0.00570
4/1/2017	In Japan, cryptocurrency exchange businesses are regulated	0.07741	0.01333	0.06409
6/6/2017	Colombian government states that cryptocurrencies are neither currency, nor legal	0.00950	0.04079	-0.03129

	tender, or security			
6/26/2017	Major Bitcoin trading platform fully licensed payment service in Luxembourg	-0.03385	0.04470	-0.07856
7/25/2017	SEC: ICOs are subject to securities laws	-0.08228	0.02924	-0.11152
8/18/2017	The Portuguese AML law imposes entities in the use of new technologies or products which are prone to favor anonymity.	0.03999	0.02751	0.01248
8/24/2017	Canadian Securities Administrators (CSA): Security laws for ICO and tokens	0.03294	0.02761	0.00532
9/4/2017	Seven central government regulators jointly issued the announcement on preventing financial risks from ICOs, which ICOs in China.	-0.06897	0.02237	-0.09133
9/5/2017	The SFC warns about the need to have a license to be able to trade tokens.	0.11510	0.02184	0.09326
9/8/2017	China shutting down all Bitcoin exchanges	-0.09654	0.02055	-0.11709
9/19/2017	FINMA: Close down unauthorized providers of e-coin, liquidated companies and warning about fake crypto	-0.03650	0.01079	-0.04729
9/29/2017	Regulatory aspects of ICO in Switzerland	0.02321	0.00961	0.01360
11/2/2017	Commercial Register Office in the Canton of Zug: Accept Bitcoin and Ether for administrative costs and as the contribution of forming a company	0.06770	0.01258	0.05513

11/6/2017	The Central Reserve Bank of El Salvador issued a statement on its position on cryptocurrencies	-0.01765	0.01476	-0.03241
11/16/2017	Brazilian Federal Reserve Bank: Not regulated, no legal tender, no electronic money, alert on the risks	0.03937	0.01610	0.02327
12/1/2017	Turkey establishes a regulatory framework for cryptocurrencies and tokens	0.06980	0.02264	0.04717
12/4/2017	Notice to investors from the AMF and Prudential Supervisory Authority	0.05897	0.02222	0.03674
12/8/2017	Authorization to create Petro backed by Venezuelan oil	-0.05912	0.02247	-0.08159
12/9/2017	French JORF legal text regarding shared electronic recording device for financial securities	-0.06767	0.02235	-0.09002
1/1/2018	The municipality of Chiasso accepts Bitcoin as a tax payment for amounts of up to 250CHF	0.09978	0.02904	0.07074
1/8/2018	The Mozambican Federal Reserve Bank issued a notice regarding Bitcoin	-0.12112	0.03311	-0.15424
1/17/2018	The Bermuda Monetary Authority issued a press release warning of the risks of ICO.	0.05010	0.03368	0.01642
1/18/2018	The Swiss State Secretariat for International Finance creates a working group of blockchain and ICO	0.05587	0.03552	0.02035
1/27/2018	The Luxembourg Minister of Finance states that cryptocurrencies are considered as currencies	0.09829	0.03021	0.06809

1/30/2018	The South Korean government implemented a rule that allows trades in cryptocurrencies only from real-name bank accounts	-0.09397	0.03242	-0.12639
2/2/2018	The German Government Public states that cryptocurrencies are considered as substitute currency	-0.01897	0.03304	-0.05201
2/5/2018	Warning about high risks by the ECB	-0.05634	0.03013	-0.08647
2/6/2018	Tokens are considered as security by the SEC	0.09059	0.02942	0.06117
2/7/2018	The French Senate announces the necessity of new legal framework to reduce illicit activities and to protect investors (higher transparency)	0.06278	0.02765	0.03512
2/8/2018	Warnings from the National Securities Commission and Bank of Spain	0.19592	0.02741	0.16851
2/12/2018	Warning to consumer from ESMA, EBA and EIOPA	0.04876	0.02311	0.02565
2/16/2018	Guidelines on the regulatory treatment of ICOs in Switzerland	0.06928	0.02575	0.04353
2/19/2018	The central bank of Uzbekistan develops a legislative framework for the use of digital money	0.02170	0.02621	-0.00450
2/20/2018	German BaFin: Regulation of ICO as financial instruments and tokens as securities	-0.07675	0.02734	-0.10409
2/22/2018	In France, AMF: Cryptocurrency derivatives, regulation of exchange related to derivative under MiFID2	-0.02164	0.02864	-0.05029

2/27/2018	Guidance on value-added tax by the German Federal Ministry of Finance	-0.01624	0.02569	-0.04193
3/1/2018	Study of the digital currency from the People's Bank of China	0.03632	0.02478	0.01154
3/7/2018	Announcement from the SEC to apply security laws to cryptocurrency companies	-0.12912	0.02428	-0.15340
3/8/2018	FinTech Action Plan in Europe	-0.04764	0.02377	-0.07141
3/12/2018	In United-Kingdom, the Financial Policy Committee consider that cryptocurrencies are not a risk for financial stability but a risk for investors	-0.04244	0.02234	-0.06478
3/14/2018	Warnings from the Financial Sector Monitoring Commission of Luxembourg	-0.10937	0.01979	-0.12916
3/15/2018	List of exchange without the requirement of the French AMF institute	-0.00618	0.01860	-0.02478
3/19/2018	The French Ministry of Economy and Finance is interested in the regulation of ICO (in purpose for investors)	0.09050	0.01601	0.07449
3/20/2018	Decision from the Central Bank of Ireland related tokens	0.02159	0.01453	0.00706
3/28/2018	Law to Regulate Financial Technology Companies in Mexico	-0.10104	0.01030	-0.11134
4/19/2018	Proposal adopted by the European Parliament	0.14308	-0.00603	0.14911
6/22/2018	The Japanese Financial Services Agency ordered cryptocurrency exchanges to improve their money laundering procedures	-0.09683	-0.00564	-0.09119

7/1/2018	In France, Ordinance blockchain authorization for more financial instruments	0.04598	-0.00806	0.05405
7/9/2018	The AMLD 5 entered into force	-0.08342	-0.00375	-0.07966
7/26/2018	In Luxembourg, circular on specific tax aspects	-0.00627	0.00099	-0.00726
8/23/2018	Cryptocurrencies are considered as commodities in US by the CFTC	0.04923	-0.00790	0.05713
10/29/2018	In United-Kingdom, Cryptoasset Taskforce related to risks, stability and DLT	-0.03021	-0.00095	-0.02925
1/30/2019	The French National Assembly starts a fact-finding mission on cryptocurrency and on the blockchain	0.01117	-0.00859	0.01976
4/4/2019	Announcement from Brazil that cryptocurrencies are not considered as securities but free to be issued, transferred and used	0.02300	0.00398	0.01902
4/9/2019	Press release from the New York State related to Bitstamp	0.00043	0.00906	-0.00863
4/11/2019	A part of the French PACTE law is related to ICO regulation	-0.05628	0.01003	-0.06631
6/6/2019	The French AMF published an instruction regarding the ICO visa	0.02951	0.01712	0.01239
Mean Return		0.00313	0.01774	-0.01461

Table 4: Market reaction to the news that treats cryptocurrencies under securities laws

This table presents the three-day returns centered on the 22 events that treat cryptocurrencies under securities laws. Raw Return is the three-day return to the 30 cryptocurrencies, centered on the event date. Past Average Return is the average return using an estimation window before the event date to exclude possible events that might influence the returns. Adjusted Return is the difference between Raw Return and Past Average Return.

Date	Raw Return	Past Average Return	Adjusted Return
8/8/2015	-0.05164	0.00381	-0.05545
3/11/2016	0.01329	0.01039	0.00290
4/28/2016	0.01740	0.00479	0.01261
3/10/2017	0.01672	0.01102	0.00570
4/1/2017	0.07741	0.01333	0.06409
7/25/2017	-0.08228	0.02924	-0.11152
8/18/2017	0.03999	0.02751	0.01248
8/24/2017	0.03294	0.02761	0.00532
9/4/2017	-0.06897	0.02237	-0.09133
9/5/2017	0.11510	0.02184	0.09326
9/8/2017	-0.09654	0.02055	-0.11709
12/8/2017	-0.05912	0.02247	-0.08159
12/9/2017	-0.06767	0.02235	-0.09002
1/30/2018	-0.09397	0.03242	-0.12639
2/12/2018	0.04876	0.02311	0.02565
2/16/2018	0.06928	0.02575	0.04353
2/19/2018	0.02170	0.02621	-0.00450
3/7/2018	-0.12912	0.02428	-0.15340
6/22/2018	-0.09683	-0.00564	-0.09119
7/9/2018	-0.08342	-0.00375	-0.07966
4/9/2019	0.00043	0.00906	-0.00863
6/6/2019	0.02951	0.01712	0.01239
Mean Return	-0.01577	0.01754	-0.03331

Table 5: Descriptive Statistics

This table presents descriptive statistics for the variables used in the regressions. The sample comprises 1,155 observations. CMAR is the cryptocurrency's cumulative market-adjusted return. Coefficient of Elasticity of Trading (CET), Amihud (2002) illiquidity measure (ILIQ), Index of Martin (MLI), Price delay (Delay), Size ln(CAP) and Trading Volume (VOL) are the variables used in the regression analyses.

Variables	N	Mean	SD	Median	Q1	Q3
<i>CMAR</i>	1155	-0.01	0.13	-0.02	-0.09	0.04
<i>CET</i>	1155	12.25	73.34	2.08	-3.83	8.77
<i>ILIQ</i>	1155	0.00001	0.00	0.00	0.00	0.00
<i>MLI</i>	1155	0.00	0.00	0.00	0.00	0.00
<i>DELAY</i>	1155	-11.99	80.90	-0.43	-1.82	-0.10
<i>ln(CAP)</i>	1155	21.62	1.94	21.60	20.43	22.76
<i>VOL</i>	1155	18.37	2.46	18.53	17.06	19.92

Table 6: Correlation Matrix

This table presents descriptive statisPearson correlations for the variables used in the regression analyses. The sample comprises 1,155 observations. CMAR is the cryptocurrency's cumulative market-adjusted return. Coefficient of Elasticity of Trading (CET), Amihud (2002) illiquidity measure (ILIQ), Index of Martin (MLI), Price delay (Delay), Size ln(CAP) and Trading Volume (VOL) are the variables used in the regression analyses.

Variables	<i>CMAR</i>	<i>CET</i>	<i>ILIQ</i>	<i>DELAY</i>	<i>MLI</i>	<i>ln(CAP)</i>	<i>ln(VOL)</i>
<i>CMAR</i>	1	0,01	0,00	-0,02	-0,01	-0,07	-0,05
<i>CET</i>		1	-0,02	0,01	-0,02	-0,07	0,15
<i>ILIQ</i>			1	0,01	-0,01	-0,23	-0,26
<i>DELAY</i>				1	-0,07	0,06	0,06
<i>MLI</i>					1	-0,05	-0,16
<i>ln(CAP)</i>						1	0,85
<i>ln(VOL)</i>							1

Table 7: Cross-sectional Analysis (Fama-Macbeth Regression)

This table presents the results from regressing the dependent variable CMAR over variables that are used in our model and represents different cryptocurrency characteristics, namely: Coefficient of Elasticity of Trading (CET), Amihud (2002) illiquidity measure (ILIQ), Index of Martin (MLI), Price delay (Delay), Size (Size), Trading Volume (Vol), Privacy (PRI) and Token (TOK); over the period 2014-2019. T-statistic is in parenthesis.

Variables	Prediction	CMAR (t-statistica)
CET	(-)	-0.000448 (-1.89)
LILQ	(+)	-248955.8 (-1.63)
MLI	(-)	-577749 (-0.59)
Delay	(+)	0.0800 (2.08)
Size	(-)	-0.012925 (-1.65)
Vol	No prediction	5.51 e-10 (0.67)
PRI	(-)	-0.009182 (-0.49)
TOK	(+)	0.01668 (0.36)
Events		63
N		1155
R²		0.5137

Table 8: Descriptive Statistics of variables used in performance regressions

This table presents summary statistics (mean, standard deviation (StD), median, sum, minimum, maximum, annualized mean and annualized volatility) of daily returns expressed in US \$ for the dependent variable ($R_{ptf}-R_f$) representing cryptocurrency portfolio return minus the risk-free rate (proxied by the one-month US Treasury Bill) and for independent variables ($R_{mkt}-R_f$ (Crix) which represents the excess return of the market portfolio using the CRIX index

$R_{mkt}-R_f$ (FF), which represents the excess return of the market portfolio using Fama-French factor, SMB, which is the size premium, HML, which is the value premium, WML which is the momentum factor). The data come from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 24 June 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 21 October 2019. All results are in percentages (%).

Variables	N	Mean (/day)	SD (/day)	Median	Sum	Max	Min	Mean/year	SD/year
<i>PRE-period</i>									
$R_{ptf}-R_f$	366	0.669	3.044	0.401	245.004	13.538	-10.88	1041.816	58.160
$R_{mkt}-R_f$ (Crix)	366	0.568	3.173	0.392	207.914	13.260	-15.98	690.577	6062.252
$R_{mkt}-R_f$ (FF)	366	0.053	0.599	0.050	19.535	2.110	-5.11	21.502	1144.928
SMB	366	0.022	0.225	0.020	8.105	1.120	-0.64	8.418	430.684
HML	366	0.004	0.342	-0.030	1.500	1.580	-0.77	1.507	652.603
WML	366	-0.022	0.479	-0.015	-8.090	2.920	-1.71	-7.752	915.815
<i>POST-period</i>									
$R_{ptf}-R_f$	366	-0.078	3.531	0.174	-28.455	12.885	-13.40	-24.715	67.451
$R_{mkt}-R_f$ (Crix)	366	0.027	3.869	0.151	9.974	15.925	-19.54	10.457	73.915
$R_{mkt}-R_f$ (FF)	366	0.010	0.746	0.065	3.595	2.600	-2.44	3.650	14.252
SMB	366	-0.023	0.320	-0.020	-8.555	1.160	-1.33	-8.179	6.106
HML	366	0.000	0.384	-0.010	-0.175	1.910	-1.07	-0.174	7.335
WML	366	-0.018	0.506	-0.010	-6.425	1.560	-2.82	-6.207	9.662

Table 9: Correlation matrix

This table presents the correlation matrix between the excess return of the cryptocurrency portfolio ($R_{ptf}-R_f$) and independent variables ($R_{mkt}-R_f$ (Crix), $R_{mkt}-R_f$ (FF), SMB, HML, WML). The sample is drawn from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 24 June 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 21 October 2019

PRE-period						
	$R_{ptf}-R_f$	$R_{mkt}-R_f$ (Crix)	$R_{mkt}-R_f$ (FF)	SMB	HML	WML
$R_{ptf}-R_f$	1.00	0.71	0.07	-0.02	0.06	-0.04
<i>p-value</i>		0.0000	0.1543	0.6518	0.2702	0.4410
$R_{mkt}-R_f$ (Crix)		1.00	0.00	0.02	0.11	-0.07
<i>p-value</i>			0.9537	0.6393	0.0372	0.1561
$R_{mkt}-R_f$ (FF)			1.00	-0.26	0.27	-0.39
<i>p-value</i>				0.0000	0.0000	0.0000
SMB				1.00	-0.04	0.10
<i>p-value</i>					0.4010	0.0460
HML					1.00	-0.27
<i>p-value</i>						0.0000
WML						1.00
POST-period						
	$R_{ptf}-R_f$	$R_{mkt}-R_f$ (Crix)	$R_{mkt}-R_f$ (FF)	SMB	HML	WML
$R_{ptf}-R_f$	1.00	-0.11	0.02	0.02	0.01	0.02
<i>p-value</i>		0.0351	0.7690	0.7295	0.8952	0.6380
$R_{mkt}-R_f$ (Crix)		1.00	-0.02	0.04	-0.01	0.03
<i>p-value</i>			0.7622	0.4319	0.8173	0.5433
$R_{mkt}-R_f$ (FF)			1.00	-0.41	-0.35	-0.26
<i>p-value</i>				0.0000	0.0000	0.0000
SMB				1.00	0.22	-0.10
<i>p-value</i>					0.0000	0.0629
HML					1.00	-0.61
<i>p-value</i>						0.0000
WML						1.00

Table 10: Performance models (366 days)

*This table presents regression estimates for the four models (Sharpe, Jensen, Fama-French and Carhart model). The sample is drawn from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 24 June 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 21 October 2019. ***, ** and * indicate that the coefficient is significant at 1%, 5% and 10% level respectively.*

Models	Sharpe Ratio	Alpha (%)	Crix_RF	Mkt_RF	SMB	HML	WML	R ² (%)	Annual alpha (%)
PRE-period									
Sharpe	0.220								
Jensen (CRIX)		0.28*	0.68***					50.89	178.10
<i>p-value</i>		0.011	<2e-16						
Jensen (FF)		0.65***		0.38				0.56	961.13
<i>p-value</i>		0.000		0.124					
Fama-French		0.65***		0.32	-0.07	0.36		0.71	974.92
<i>p-value</i>		0.000		0.221	0.916	0.4334			
Carhart		0.65***		0.31	-0.07	0.35	-0.04	0.71	973.98
<i>p-value</i>		0.000		0.271	0.917	0.464	0.914		
POST-period									
Sharpe	-0.022								
Jensen (CRIX)		-0.08	-0.10*					1.21	-23.96
<i>p-value</i>		0.691	0.049						
Jensen (FF)		-0.08		0.07				0.02	-24.91
<i>p-value</i>		0.665		0.786					
Fama-French		-0.07		0.15	0.31	0.11		0.11	-23.08
<i>p-value</i>		0.689		0.620	0.641	0.842			
Carhart		-0.06		0.48	0.53	0.96	0.83	0.61	-18.22
<i>p-value</i>		0.759		0.256	0.448	0.240	0.239		

Table 11: Descriptive Statics of variables used in performance regressions for longer periods of time

This table presents summary statistics (mean, standard deviation (StD), median, sum, minimum, maximum, annualized mean and annualized volatility) of daily returns expressed in US \$ for the dependent variable ($R_{ptf}-R_f$) representing cryptocurrency portfolio return minus the risk-free rate (proxied by the one-month US Treasury Bill) and for independent variables ($R_{mkt}-R_f$ (Crix) which represents the excess return of the market portfolio using the CRIX index

$R_{mkt}-R_f$ (FF), which represents the excess return of the market portfolio using Fama-French factor, SMB, which is the size premium, HML, which is the value premium, WML which is the momentum factor). The data come from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 14 April 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 31 December 2019. All results are in percentages (%).

Variables	N	Mean	SD	Median	Sum	Max	Min
Panel A : PRE period							
$R_{ptf}-R_f$	437	0.613	2.887	0.355	268.039	13.538	-10.880
$R_{mkt}-R_f$ (Crix)	437	0.567	3.154	0.436	247.800	13.260	-15.983
$R_{mkt}-R_f$ (FF)	437	0.052	0.604	0.050	22.795	2.110	-5.110
SMB	437	0.024	0.240	0.025	10.525	1.120	-0.770
HML	437	0.002	0.339	-0.030	1.080	1.580	-1.210
WML	437	-0.008	0.510	-0.015	-3.610	2.920	-1.710
Panel B : POST period							
$R_{ptf}-R_f$	437	-0.129	3.403	0.089	-56.237	12.885	-13.405
$R_{mkt}-R_f$ (Crix)	437	-0.013	3.749	0.083	-5.481	15.925	-19.538
$R_{mkt}-R_f$ (FF)	437	0.035	0.698	0.090	15.135	2.600	-2.440
SMB	437	-0.012	0.302	-0.010	-5.325	1.160	-1.330
HML	437	-0.008	0.374	-0.020	-3.515	1.910	-1.070
WML	437	-0.018	0.493	0.000	-8.055	1.560	-2.820

Table 12: Period Models for longer periods of time (437 days)

*This table presents regression estimates for the four models (Sharpe, Jensen, Fama-French and Carhart model). The sample is drawn from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 14 April 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 31 December 2019. ***, ** and * indicate that the coefficient is significant at 1%, 5% and 10% level respectively.*

Models	Alpha (%)	Crix_RF	Mkt_RF	SMB	HML	WML	R ² (%)	Annual alpha
PRE-period								
Jensen (CRIX)	0.24*	0.65***					50.74	143.13
<i>p-value</i>	0.011	<2e-16						
Jensen (FF)	0.60***		0.17				0.13	801.65
<i>p-value</i>	0.000		0.389					
Fama-French	0.62***		0.10	-0.31	0.28		0.30	837.34
<i>p-value</i>	0.000		0.634	0.593	0.483			
Carhart	0.61***		0.14	-0.32	0.32	0.12	0.33	833.95
<i>p-value</i>	0.000		0.551	0.583	0.451	0.659		
POST-period								
Jensen (CRIX)	-0.13	-0.09					0.97	-37.76
<i>p-value</i>	0.435	0.057						
Jensen (FF)	-0.13		0.06				0.02	-37.57
<i>p-value</i>	0.419		0.810					
Fama-French	-0.13		0.12	0.29	0.06		0.08	-37.57
<i>p-value</i>	0.424		0.664	0.645	0.900			
Carhart	-0.12		0.43	0.48	0.85	0.77	0.52	-34.70
<i>p-value</i>	0.466		0.276	0.461	0.249	0.228		

Table 13: Residual Analysis

This table presents the residuals analysis from the long-run regressions in the PRE and POST periods. The sample is drawn from the Coinmarketcap and Kenneth R. French's websites over the PRE-period 14 April 2016 to 24 June 2017 and over the POST-period 21 October 2018 to 31 December 2019. The residuals autocorrelation hypothesis is tested using the Durbin-Watson statistic: if the Durbin-Watson statistic is around 2 and the null-hypothesis of non-autocorrelation is accepted, then the residuals are considered uncorrelated. The homoscedasticity hypothesis is tested based on the studentized Breusch-Pagan: if the p-value is lower than 5 per cent, the null hypothesis of homoscedasticity is rejected. The normality hypothesis is based on the Shapiro-Wilk test: if the p-value is lower than 5 per cent, the null hypothesis of normality is rejected.

	Autocorrelation (Durbin- Watson)	Homoscedasticity (studentized Breusch-Pagan)	Normality (Shapiro- Wilk)
PRE-period			
Jensen (CRIX)	1.99	6.35	0.94
<i>p-value</i>	0.944	0.01174	0
Jensen (FF)	1.86	0.00	0.92
<i>p-value</i>	0.15	0.9922	0
Fama- French	1.85	3.27	0.92
<i>p-value</i>	0.13	0.3517	0
Carhart	1.85	4.02	0.92
<i>p-value</i>	0.154	0.4037	0
POST-period			
Jensen (CRIX)	1.88	0.05	0.93
<i>p-value</i>	0.26	0.8283	0
Jensen (FF)	2.09	3.56	0.93
<i>p-value</i>	0.446	0.05928	0
Fama- French	2.09	3.71	0.93
<i>p-value</i>	0.41	0.2941	0
Carhart	2.12	3.77	0.94
<i>p-value</i>	0.33	0.4387	0

Figure 1: Taxonomy of money adapted from the Bank for International Settlements in 2017 (Bench and Garratt, 2017).

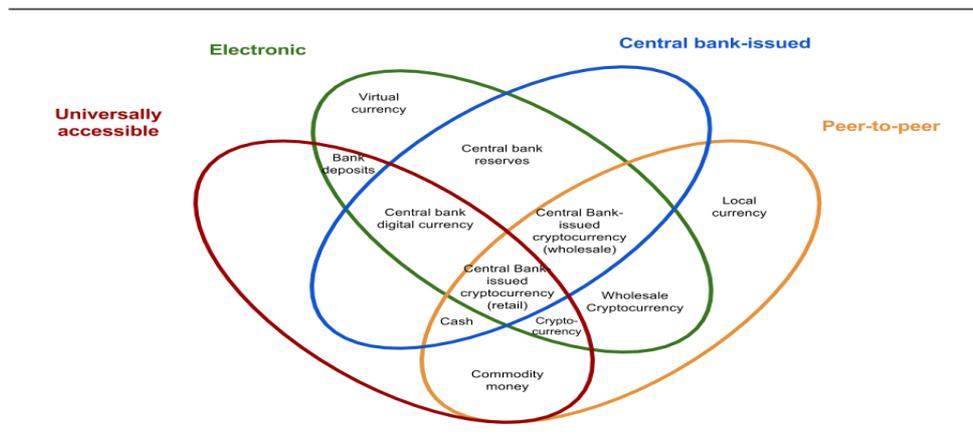


Figure 2: Short-term market reaction predictions (H1)

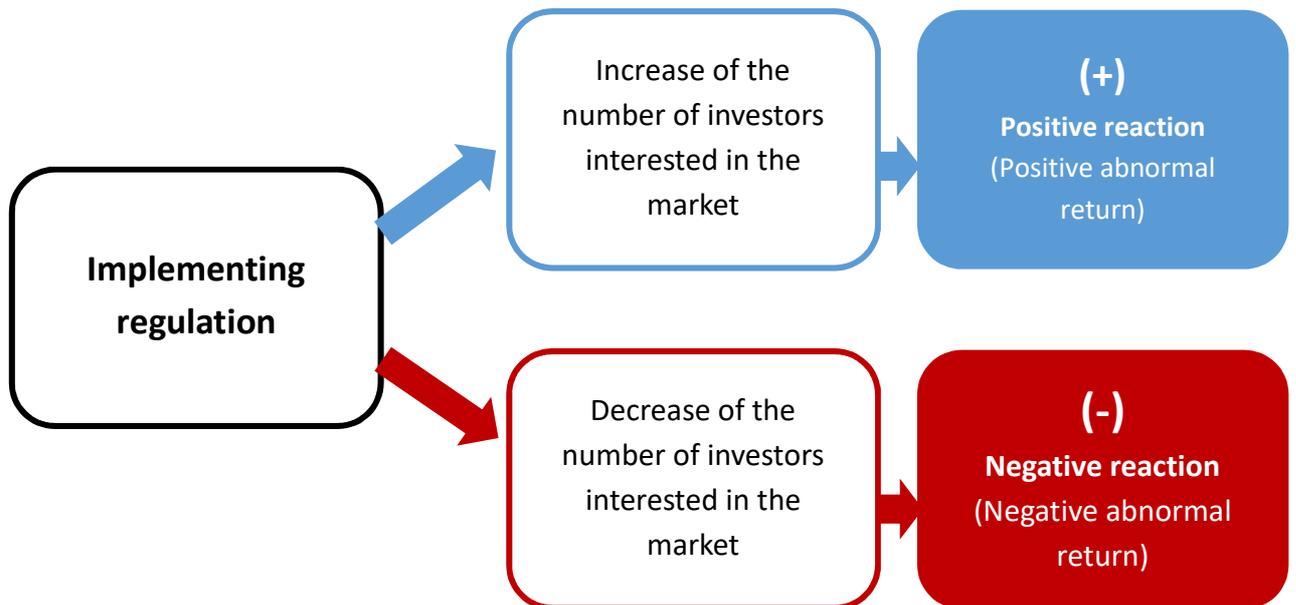
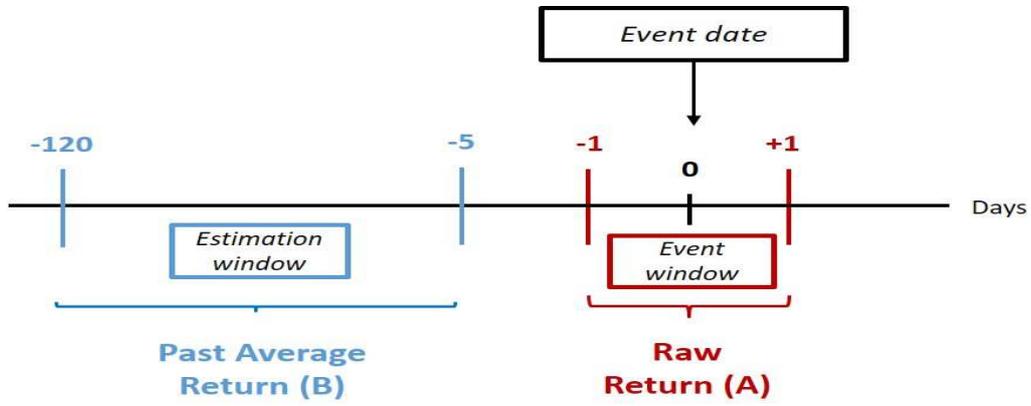


Figure 3: Event study Timeline



Adjusted Return = Raw Return (A) - Past Average Return (B)

Figure 4: Histogram of Events

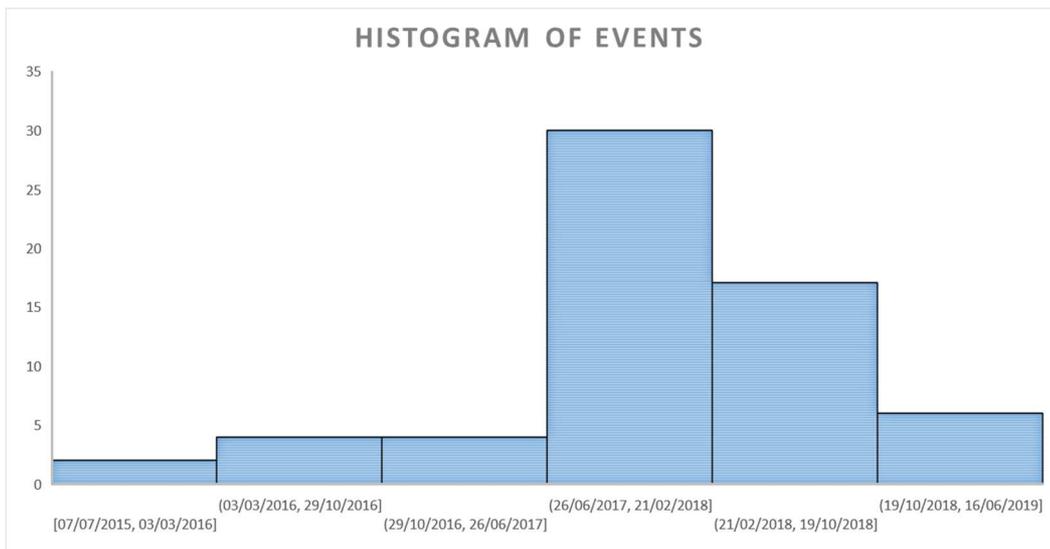


Figure 5: PRE and POST periods Timeline

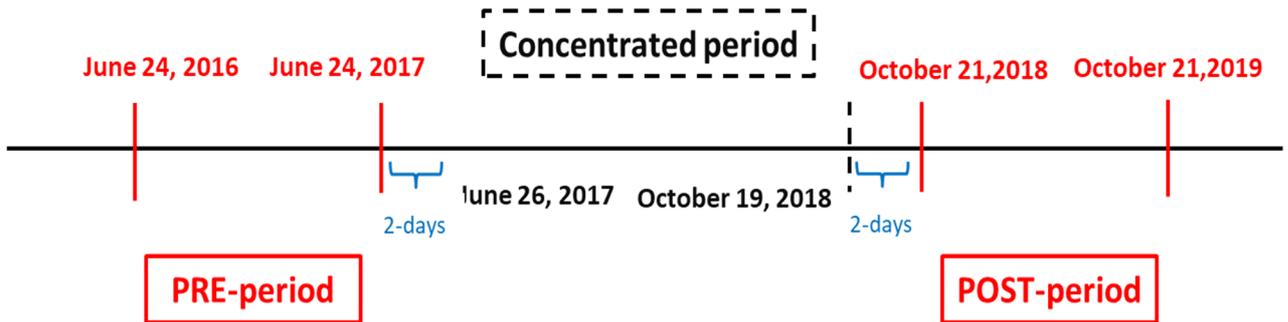


Figure 6: Closing prices of the seven crypto-currencies in the portfolio

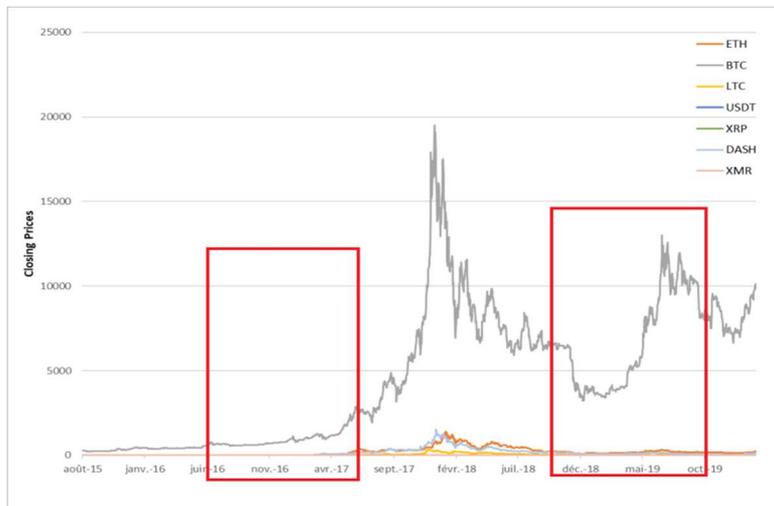


Figure 7: Closing prices of crypto-currencies in the portfolio except Bitcoin



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