



T.C.
DOĞUŞ UNIVERSITY
GRADUATE EDUCATION INSTITUTE
BUSINESS ADMINISTRATION

ANNOUNCEMENT EFFECT ON CRYPTOCURRENCIES

Master's Thesis

Prepared by
ANDREI SIDOROV

Istanbul, 2025



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Prepared by
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I stated that this study titled “Announcement effect on cryptocurrencies”, which I submitted as a Master's Thesis was written by me in accordance with scientific morals and traditions, that I obtained all the information in this thesis within academic and ethical rules, that all the works I benefited from are shown in the sources and that my study I state that they are referenced wherever they are used, and that I have not acted in violation of patents and copyrights, and I proudly confirm this.



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ÖZET

KRİPTO PARA PİYASASINDA DUYURU ETKİSİ

Bu çalışma, piyasa oynaklığı ve istikrarını dikkate alarak kamu duyurularının, düzenleyici kararların ve önemli olayların Bitcoin, Ethereum, Ripple ve Dogecoin kripto paralarının fiyat hareketleri üzerindeki etkisini incelemektedir. 03 Haziran 2017 ile 27 Ekim 2024 tarihleri arasındaki dönem için 2700'den fazla günlük fiyat hareketi incelenmiştir. Çalışmanın birincil amacı duyurulara kripto paraların verdiği tepkinin incelenmesi, piyasa davranışındaki kalıpların ortaya çıkarılması ve piyasa duyarlılığının değerlendirilmesidir. Çalışmanın bulguları Dogecoin gibi oynaklığı yüksek varlıkların pozitif duyurular karşısında daha belirgin ve daha uzun süreli fiyat değişimleri gösterdiğini, Bitcoin ve Ethereum benzeri daha istikrarlı kripto paraların ise nispeten daha sınırlı fiyat değişimleri gösterdiğini ortaya koymaktadır. Öte yandan çalışma, yasal düzenlemeler ya da piyasa aksaklıkları benzeri negatif duyuruların kripto para fiyatları üzerinde uzun ve yıpratıcı etki yaptığını göstermektedir. Buna ek olarak çalışma kripto para piyasasının katılımcı sayısı artması ile daha istikrarlı bir hale geldiğini göstermektedir. Bitcoin ve Ethereum orta seviyede bir oynaklığa sahipken, Dogecoin ve Ripple'ın daha yüksek bir oynaklığa sahip olduğu görülmektedir. Çalışma aynı zamanda Bitcoin ve Ethereum arasındaki yüksek korelasyona benzer şekilde kripto paralar arasında piyasa manipölasyonuna potansiyel oluşturacak seviyede yüksek bir korelasyon olduğunu göstermektedir. Yatırımcı psikolojisi pozitif olması durumunda fiyatı artışlarını yönlendirirken, negatif olması durumunda ise piyasayı düşüşlerini tetikleyerek duyurunun etkisini büyötmektedir. Bu araştırma, yatırımcılara kripto para piyasasındaki dalgalanmaları yönetmelerini ve daha bilinçli yatırım kararları vermelerini sağlayacak bilgiler sunmayı hedeflemektedir.

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ABSTRACT

ANNOUNCEMENT EFFECT ON CRYPTOCURRENCIES

This study examines the influence of public announcements, regulatory actions, and significant events on the price movements of Bitcoin, Ethereum, Ripple, and Dogecoin, focusing on market volatility and stability. Historical exchange rate data, covering the period from 03 June 2017 to 27 October 2024, with over 2700 daily price observations, were analyzed. The primary aim was to explore how these events shape cryptocurrency price reactions, uncover patterns in market behavior, and assess market sentiment. The findings reveal that volatile assets like Dogecoin experience more pronounced and longer-lasting price changes in response to positive announcements, while more stable cryptocurrencies such as Bitcoin and Ethereum show relatively brief price shifts. Negative events, especially those involving regulatory actions or market disruptions, tend to have a prolonged and detrimental effect on cryptocurrency prices. Additionally, the study highlights the growing stability of the cryptocurrency market, driven by an expanding user base. Bitcoin and Ethereum exhibit moderate volatility, while Dogecoin and Ripple show higher volatility. The research also identifies correlations between cryptocurrencies, such as the strong relationship between Bitcoin and Ethereum, suggesting potential for price manipulation between correlated assets. Investor sentiment plays a crucial role in amplifying the effects of both positive and negative events, with favorable sentiment driving price increases and negative sentiment contributing to market declines.

This research provides valuable insights for investors, enabling them to navigate cryptocurrency market volatility and make more informed investment decisions.

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INTRODUCTION

Since Bitcoin's creation in 2009, the cryptocurrency market has seen rapid growth. What was considered once a niche market, with unofficial trading in the beginning, now operates 24/7 across more than 500 exchanges [80]. However, in terms of capitalization cryptocurrency market is still far smaller than the global stock market \$1.86 Trillion vs \$109 Trillion [22, 23]. Announcement effect is otherwise in the context of financial markets is over than 60 years old [81]. At that time, the origin of the announcements was primarily local, and the rate at which the information spread was slower. These days the global access to the Internet along with ubiquitous social media platforms opens the gates for deception and manipulation [82].

Cryptocurrency market manipulation refers to strategies aimed at altering cryptocurrency prices, often leading to artificially high or low values compared to what would occur under typical market conditions. Common manipulation tactics in both cryptocurrency and traditional financial markets include pump-and-dump schemes, spoofing, wash trading, and insider trading. Although the Securities and Exchange Commission (SEC) has increased its efforts to regulate cryptocurrency markets, these markets still face less regulation and enforcement compared to more established financial markets like stock exchanges. Consequently, cryptocurrency markets remain more vulnerable to manipulation [83].

Insider trading, a long-standing issue in financial markets, can also take place in cryptocurrency markets. It happens when individuals use confidential information about a cryptocurrency to manipulate the market. This often involves using privileged knowledge of upcoming announcements, such as new cryptocurrency listings or major news that could significantly impact the market [83].

The motivations behind this study are as follows:

1. Exploring the History and Evolution of the Cryptocurrency Market: Investigate the development of cryptocurrencies, the underlying technology, and the factors contributing to their popularity.
2. Analyzing the Influence of Announcements on Cryptocurrency Prices and Market Behavior: Examine how various announcements, such as regulatory

changes, technological developments, public statements by opinion leaders, and black swan events, impact cryptocurrency prices and market dynamics.

3. **Forecasting Cryptocurrency Price Movements:** Forecast the price movements of selected cryptocurrencies by analyzing market trends and considering the impact of existing announcements, providing predictive insights into future market behavior.
4. **Assessing the Stability and Volatility of the Cryptocurrency Market:** Identify trends and patterns in the behavior of selected cryptocurrencies over time to understand market stability and volatility.
5. **Understanding the Impact of External Factors on Cryptocurrency Price Movements:** Explore how market sentiment and economic conditions shape cryptocurrency price movements.
6. **Providing Actionable Insights and Recommendations for Investors:** Offer strategies to navigate the volatility of the cryptocurrency market and capitalize on price movements influenced by announcements.

Expected Contributions to Existing Literature:

- a. **Expanding Knowledge on the Announcement Effect in Cryptocurrency Markets:** The study aims to provide a more comprehensive understanding of how various types of announcements, including black swan events, influence cryptocurrency prices and market behavior.
- b. **Comparative Analysis of Cryptocurrency Behavior:** It aims to offer insights into trends and patterns in the behavior of selected cryptocurrencies over time, contributing to a deeper understanding of market stability.
- c. **Insights into External Factors Affecting Cryptocurrency Prices:** The study seeks to enhance understanding of how external factors, such as market sentiment and economic conditions, shape cryptocurrency price movements.
- d. **Practical Recommendations for Investors:** By providing actionable insights, the study intends to assist investors in navigating market volatility and capitalizing on price movements driven by announcements, including black swan events.

In the first section, the history, purpose, and technology of cryptocurrencies are examined, along with a literature review. In the second section, the process of data collection and the methodology used for analysis are described. In the third section,

the results are presented and analyzed, focusing on the impact of various announcements on cryptocurrency prices and market behavior.



FIRST PART

FOUNDATIONS AND LITERATURE REVIEW

1.1 History of Cryptocurrency Market

All the existing markets more or less are similar, and digital market is not an exception as it tries to copy the ones that already exist [84]. Global digitalization influences every market, but cryptocurrency market claims to be the most affected by the media [85]. At the same time so-called Black Swans that usually cause negative impact on the stock and foreign exchange markets, otherwise can be positive for cryptocurrencies [86]. In terms of similarity, cryptocurrency market rather reminds of foreign exchange market, it also has a rather small amount of most traded currencies [87].

The Digital Revolution or The Third Industrial Revolution that started in 1947 and is still in progress now, forced many sectors to change or rather to adapt to the new reality [1]. Invention of the Internet in 1969 along with invention of the World Wide Web in 1989 played a significant role in changing every possible business aspect, every institution and almost everything that surrounds us in general. Information flows have become much faster, and the amount of the information itself keeps steadily increasing. For example, in 2008 Business Information Consumption has been estimated at unbelievable 9,570,000,000,000,000,000 bytes (9.57 zettabytes or 9,570,000,000 terabytes) a year [2]. Apart from constantly increasing amount of created data, there is an artificial intelligence that, according to Max Roser's article, will be developed within the next few decades, as 90% of the questioned experts gave a date within next 100 years [3].

Digitalization affects financial institutions and markets as well. There are two types of markets: money and capital. The concept of a money market has been around for centuries, however the modern market as we know it first took shape in the XX century. The development of money market instruments and practices has evolved over time to meet the changing needs of the financial system. As well as money market capital markets have a long history dating back centuries. The Amsterdam Stock Exchange, established in 1602 by the Dutch East India Company (Verenigde Oost-

Indische Compagnie (VOC)), is considered the world's first official stock exchange [4]. However, various forms of capital markets and financial instruments have existed even earlier in different cultures. For example, in the Roman Empire there was no capital market, however people, according to Peter Temin's article, have already been able to invest their money. More than that, they were showing financial sophistication and understanding that investors must think about opportunity cost of invested funds if they were borrowed or not [5]. Over the centuries capital markets have evolved and expanded globally to facilitate the buying and selling of financial instruments.

Considering existing risks, digitalization and the demand of people to remain anonymous when they purchase goods or make other transactions – the concept of cryptocurrency was developed. Oxford dictionary describes cryptocurrency as a digital currency in which transactions are verified and records maintained by a decentralized system using cryptography, rather than by a centralized authority. As for now, Bitcoin is the most popular and valuable cryptocurrency with its \$2.01 trillion market capitalization (2024), introduced in 2009 by a mysterious person no one has ever seen - Satoshi Nakamoto [28]. However, Bitcoin is not clearly the first cryptocurrency as the concept of it is far older. The concept of a cryptocurrency was created and described by cryptographer David Chaum in his article «Blind Signatures for Untraceable Payments» published in 1983. Of course, there was no such a term (cryptocurrency) back then, so in fact David Chaum in his article rather introduces a new kind of cryptography called «blind signatures» that can be used in untraceable payment systems offering advanced level of personal privacy, auditability and control compared to the existed systems. There he also touches some well relevant today cryptocurrency - related problems such as: criminal use of payments, substantial personal privacy, impact on the nature, lack of control and security [6]. Later, he founded an electronic cash company named DigiCash in 1989 and the first ever electronic money called eCash [17].

In 1998 Wei Dai published b-money proposal where a digital decentralized currency system was described. The key ideas mentioned in b-money were similar to the ones that were used for Bitcoin such as: Decentralization (a system where participants would maintain as shared ledger of accounts, removing the need of a central authority), Proof of Work (the idea of using computational effort with economic

incentives for the users contributing their resources to secure the system), Smart contracts and Anonymity (a system of smart contracts and accounts with only pseudonyms as names to enable anonymous transactions without trust in third parties were discussed in the following proposal) [76].

In the same year (1998) another proposal was introduced. Nick Szabo, a computer scientist and a cryptographer proposed Bit Gold that wasn't implemented; however, the concept was even more like Bitcoin itself than any other digital currency. The primary ideas in Bit Gold were: Proof of work (Nick Szabo proposed using computational puzzles to generate the currency that would be distinctive, limited and possess inherent value due to the effort needed to get produced), Decentralized ledger (a public ledger would be used for transactions and ownership of Bit Gold that is maintained by the participants in the network), Decentralization (similarly to b-money the system that is relied on cryptography and peer – to – peer verification is proposed to eliminate the need of intermediaries like banks), Immutable records (the concept Nick Szabo proposed included a tamper-proof chain of blocks to store records – that had a significant impact on Bitcoin's blockchain technology) [77].

In 1997 Adam Black developed Hashcash – a system that was designed to confront spam emails and other types of network abuse by forcing senders to solve computational puzzles. The key concepts of Hashcash were: Proof of Work (the concept was that the email sender must demonstrate they spent computational resources in order to send it – the following concept later served as the foundation for the mining algorithm in Bitcoin), Computational puzzles (Hashcash required the sender to find a nonce that, when hashed with the recipient's address and timestamp, produced a hash with a specific number of leading zeroes, the difficulty could be adjusted to ensure it took a reasonable time to solve), Anti-Spam and Abuse prevention (By embedding the computational work in email headers, Hashcash made it costly for spammers to send bulk emails, as solving the puzzle was time-consuming and resource-intensive) [78].

Hal Finney expanded on Adam Black's Hashcash to create Reusable proof of work (RPOW) in 2004. The system that allowed users to reuse Proof of work tokens for digital transactions and despite the fact it was on a centralized server it was an

important step toward Bitcoin's decentralization Proof of work system development [79].

Bitcoin was developed using the following technologies with the purpose to make transactions online easier avoiding banks and other payments systems, as the most of them are: not fast enough (SWIFT), expensive to deal with (have high fees), bureaucratic, not secure enough. However, remains a mystery who or what entity behind this cryptocurrency is. Therefore, it is fair to assume it might end up being a financial pyramid after all, as there are no assets at all behind it. Despite this, cryptocurrencies formed up an own unique cryptocurrency market, as according to CoinMarketCap there are now more than 23000 different cryptocurrencies in the world [18]. At the same time the number of real currencies is far lower – 180 that circulating in 197 countries [19]. Similarly, to foreign exchange where the majority of payments made using the United States Dollar, the Euro, Great Britain Pound, Japanese Yen, or Chinese Yuan cryptocurrency market also has top traded currencies such as: Bitcoin, Ethereum, Tether USDt, Binance coin, Ripple and so on [20, 21]. However, in terms of capitalization cryptocurrency market is still far smaller than the global stock market \$3.91 Trillion vs \$109 Trillion [22, 23].

Cryptocurrency market, as for now, is not as well developed as other existing market. Appearance of brokers and other platforms, has, first of all, erased anonymity of crypto currency owners, as the majority of them require personal data only to register there. In fact, without this key feature of a cryptocurrency there is not a big difference between crypto and real currency for that matter. And indeed, for example, banks know everything about their clients so do platforms such as Binance, Coinbase and so on. Basically, the only advantage remaining is speed, as transactions are made faster than SWIFT, however the amount of risk might be even higher. As it was mentioned above, there is plenty of risks when it comes to finance, despite that, according to Nobel prize winner Richard Thaler people make illogical and irrational choices all the time and in a highly predictable manner [24]. More than that, there is another one upcoming risk for cryptocurrency owners. Blockchain technology is well known for its security, however the question is – Will it still be secure enough when Artificial Intelligence gets invented that will be also able to guess all the passwords?

Many scholars seek to understand the impact of the announcement effect, as it is easier to influence a smaller market than a larger, more stable one [88]. Obviously, if the market keeps getting more and more investors is considered healthy, or, otherwise, if everyone loses interest and quits everything collapses. However, when it particularly comes to cryptocurrency market it is far worse, as cryptos have nothing behind them (no real assets) meaning the risk of losing everything is extreme [89]. Cryptocurrencies have far more problems that require research, for example plenty of legal issues, as in many countries they are considered illegal, experts keep arguing if cryptoassets can be considered as a property or not, dealing with exchange offices and crypto markets force investors to register with their IDs so cryptocurrencies lose one of their key purpose such as anonymity and so on [90]. Considering all this cryptocurrency market remains a mystery and requires complex research that combines different disciplines to be able to forecast it and to be able to find out if it will become a real market or fade away like financial pyramids

1.2. Blockchain Technology

Block chain technology was introduced by the same mysterious individual or a group of individuals named Satoshi Nakamoto in the article called «Bitcoin: A Peer-to-Peer Electronic Cash System» published in 2008 as a technology Bitcoin based on [33].

By analyzing the article that explains not only how blockchain technology works but what bitcoin is made for – it is fair to compare the ideas of David Chaum’s eMoney to Satoshi Nakamoto’s Bitcoin and blockchain ideas in general.

Table 1. The Difference Between Key Digital Currency Ideas

David Chaum’s eMoney ideas	Satoshi Nakamoto’s Bitcoin / Blockchain ideas
Focus on Privacy Chaum’s work, especially with DigiCash declares the importance of privacy in digital transactions and his concept called «blinded signatures» allowed for anonymous transaction	Trustless System The Bitcoin system relies on cryptographic proof rather than trust in a central authority. All transactions are recorded on a public blockchain that is maintained by a decentralized network of

where the identity could be hidden from everyone in the chain.	miners who strive to secure the network and to validate all the transactions.
Centralized Trust Model Chaum's digital cash system was still relying on central (bank – like) authority that was issuing and verifying the currency.	Decentralization Nakamoto's idea is to eliminate the need for a central authority therefore instead of relying on a trusted third-party Bitcoin uses a peer-to-peer network where transactions are verified by multiple so-called nodes guaranteeing integrity and security through computational proof.
Preventing Double-Spending Double – spending was prevented by the same central authority that was verifying every transaction.	Double – Spending solution Nakamoto managed to solve double-spending problem by using an allocated timestamp server that orders all the transactions chronologically. The system is secured by proof – of – work that makes it impossible for anyone to change the transaction history or to spend Bitcoin twice.
Does not have any economic incentives Chaum's eMoney had no incentives for participants over time apart from anonymous transactions. In other words, a person could only exchange his money to eMoney issued by a central authority to then make an anonymous transaction.	Does have economic incentives Nakamoto's system allows participants (so-called miners – the ones that provide their own hardware to the system) to get rewarded with bitcoins and transaction fees for securing the network.

Source: [6, 33].

Based on the comparison of the key ideas made in the Table 1 it is still impossible to say what approach is better. Every approach has its pros and cons and is rather depended on the specific needs, values of the individuals and the context in which the digital currency is being used. However, it is fair to assume that economic

incentives for the participants of the process are surely one of the primary factors that made Bitcoin far more popular than eMoney.

However, this time not only Bitcoin was an interesting contribution to the society but the technology itself as well. Melanie Swan in her book «Blockchain: Blueprint for a New Economy» describes 3 categories of Blockchain such as:

- Blockchain 1.0 that is currency. It stands for the deployment of cryptocurrencies in apps related to cash and consequently currency transfer, digital payment systems and so on.
- Blockchain 2.0 she describes as contracts. Blockchain 2.0 is used in financial applications to operate financial instruments such as: stocks, bonds, mortgages, smart property and smart contracts. The last one can be defined as a self-executing contract when the terms of the agreement are written right in the code, so it automatically enforces and executes the terms and the conditions when specified conditions are met without the need for third parties like lawyers or banks.
- Blockchain 3.0 are blockchain applications that are beyond cryptocurrencies, finance and markets. Blockchain 3.0 is more secure than 1.0 and 2.0, extremely flexible, expandable offering long-term stability. It can be used in vast number of areas such as: health, government, culture, science, art, literacy and so on [34].

More than that, some authors not only categorize but typify blockchain as well. Daniel Drescher in his book «Blockchain basics: a non-technical introduction in 25 steps» describes 4 types of block chain such as:

- Public Blockchain: That is fully decentralized, open and accessible to anyone who uses.
- Private Blockchain: That has a restricted access, usually within a single organization or a group of people.
- Consortium Blockchain: That is managed by a group of organizations, is not fully decentralized, at the same time not as restricted as private blockchains.
- Hybrid Blockchains: Has features of both public and private blockchains customized for specific needs [35].

Of course, blockchain technology develops rapidly and some authors might come up with a bigger amount of types and categories, however here, first of all, it is essential to realize how it actually works.

Satoshi Nakamoto in his article first explains how blockchain works with transactions. He defines an e-coin as a series of digital signatures then each owner passes the coin to the next one by digitally signing a hash (fixed-size string of characters generated by a hash function, which is a type of cryptographic algorithm) of the preceding transaction along with the public key of the new owner then adding theses to the end of the coin and the recipient can verify the signature to verify the ownership later on [33]. The process is shown in the Figure 1.

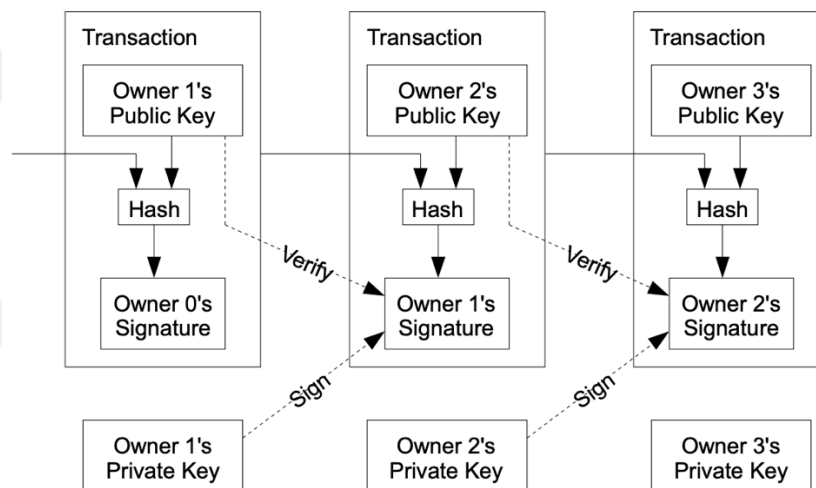


Figure 1. Transactions Using Blockchain Technology

Source: [33].

Nakamoto allocates the problem of this method – the recipient can't verify if one of the owners did double-spend the coin. Then he says that making a central authority could be a solution (exactly what David Chaum was offering), however for decentralized system it is essential to know about the earliest transaction and it doesn't matter if someone tries to double-spend later one, therefore the only way to find if there's no particular transaction is to be aware of all transactions [33]. That's why once an individual decides to download a wallet from the official Bitcoin website it will be a massive file that has the information about all made transactions since the launch day.

The proposed solution to avoid double-spending starts with a timestamp server that's works by capturing a hash of a block of items to create a timestamp and widely distribute the hash such as in an usenet post or a newspaper. This timecode proves that the data must have existed at the time in order to get into hash and each timecode has prior timestamp forming a chain having additional timestamps securing previous ones [33]. Figure 2 displays a forming up chain of transactions using timestamp server.

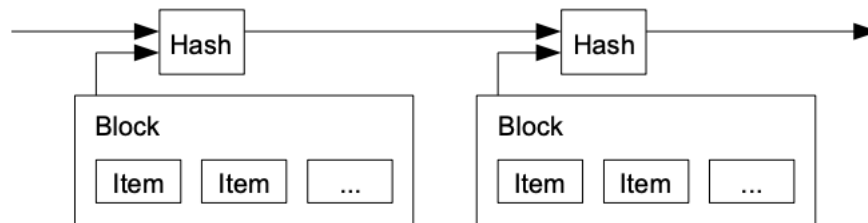


Figure 2. A Chain of Transactions Using Timestamp Server

Source: [33].

To execute a timestamp server on P2P (peer-to-peer) basis there is a need to use a proof-of-work system that is similar to Hashcash, rather than Usenet posts or newspaper. The system scans for a value that when hashed like, for example, with SHA-256 (secure hash algorithm 256-bit – a cryptographic hash function that is developed by the National Security Agency (NSA)) and the hash starts with a number of zero bits. The algorithm and therefore the amount of work required is exponential in the count of zero bits needed, which can be confirmed by performing a single hash. Nakamoto implements proof-of-work system by incrementing a nonce until the block's hash meets the required zero bits and once a block is validated, altering it would require redoing all subsequent blocks. Proof-of-work solves another issue that is subversion by ensuring fair representation in decision-making by using one-CPU-one-vote instead of using one-IP-address-one-vote. The longest chain that reflects the most proof-of-work represents the majority decision. The author mentions the security advantage of the system due to exponential difficulty over time as to alter a past block a protentional attacker must redo and surpass the proof-of-work system of that block and all subsequent blocks as well. Proof-of-work difficulty keeps adjusting with hardware speed and node interest to maintain a consistent block generation rate [33]. Figure 3 displays how a timestamp server works with a proof-to-work system.

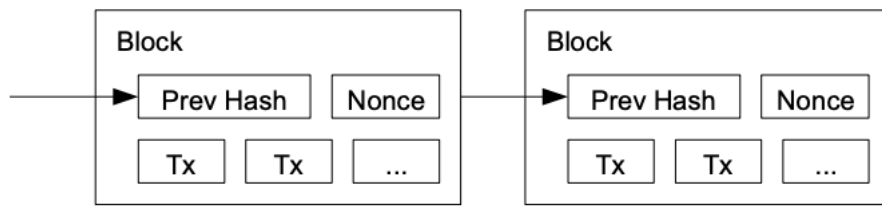


Figure 3. A Chain of Transactions Using Proof-to-Work

Source: [33].

In the same article Nakamoto comes up with an idea of economic incentives – exactly the thing that might make bitcoin and other cryptocurrencies popular later. The idea is the first transaction in each block creates a new coin for the block creator encouraging network support and distributing coins at the same time as there is no central authority to issue them. He compares it to gold mining where the power of hardware along with electricity replace gold mining efforts. So, the reward includes new coins along with transaction fees. The author underlines that this idea as well helps to keep nodes honest as a protentional attacker with vast hardware resources would rather prefer to follow the rules due to the ability of issuing new coins simply because it is more profitable than to defraud people in the system [33].

Another important thing is disk space as to deal with Bitcoin and blockchain technology a user needs to download the information about all the transaction happened since the first day of its launch and as long as the disk space is not limitless and the fact, they can be expensive when it comes to high capacity hard drives the system has to be flexible and adaptive. The blockchain technology presented by Satoshi Nakamoto uses so-called Merkel Tree (a cryptographic data structure used to efficiently and securely verify the integrity of large sets of data) that is shown in the Figure 4. He declares that a block header without any transactions takes about 80 bytes and if blocks are generated every 10 minutes within a year it would be $80 \cdot 6 \cdot 24 \cdot 365 \approx 4,2$ MB per year, as well as memory that according to Moore's law growing 1.2Gb a year in personal computers therefore storage should not be a problem even if the block headers must be kept in memory ram [33].

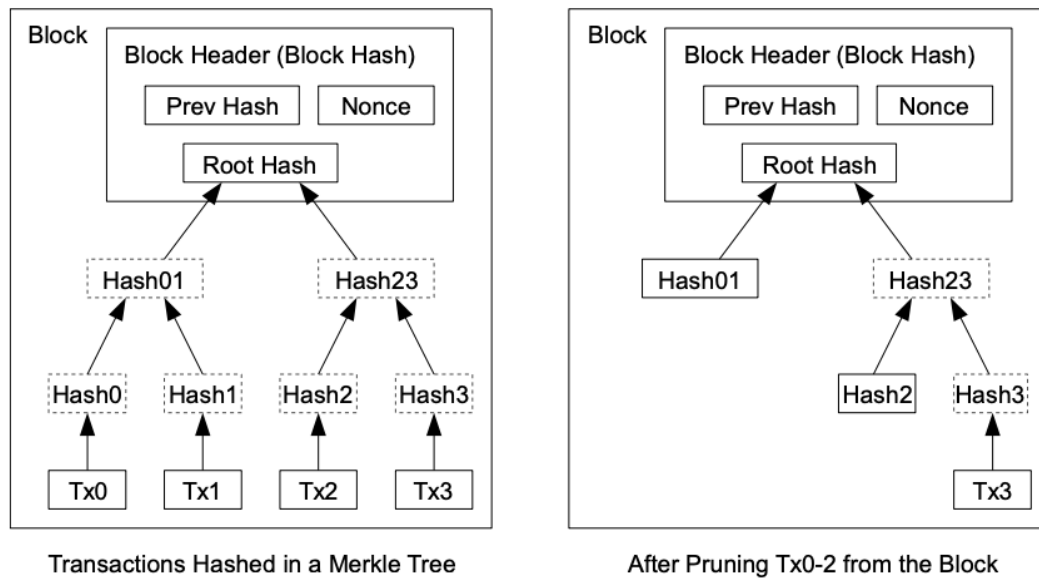


Figure 4. Saving Disk Space by Using Merkle Tree

Source: [33].

To simplify the payment verification Nakamoto made it possible to verify payments without running a full network node by keeping the block headers of the longest chain and obtaining the Merkle branch for the transaction, like it is displayed in the Figure 5. This particular method displays that the transaction is accepted by the network, but it is less reliable if an attacker controls the network. To prevent it, users can get alerted from nodes about invalid blocks and then verify by downloading the full block, at the same time companies that receive frequent payments may prefer running their own nodes for faster verification and better security [33].

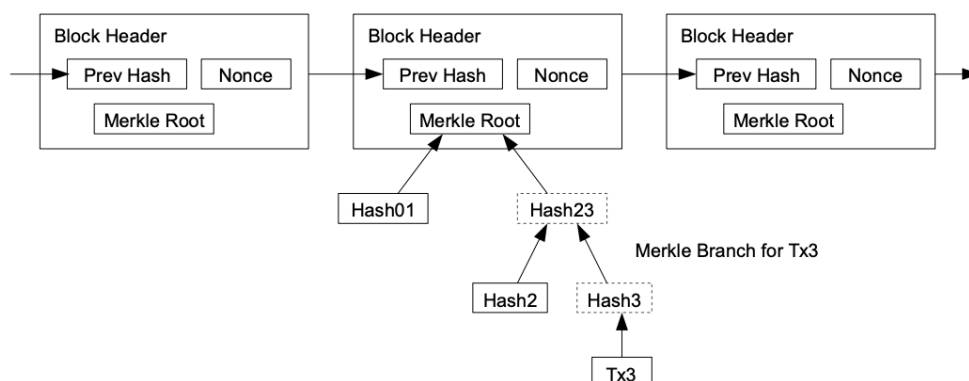


Figure 5. Longest Proof-of-Work Chain

Source: [33].

In a blockchain system to efficiently manage and transfer value transactions are designed to handle multiple inputs and outputs - instead of making separate transactions for each small unit of value transactions combine multiple smaller amounts into a single transfer and can produce multiple outputs, such as the payment amount and any change returned to the sender like it, it is displayed in the Figure 6. This allows the efficient handling of value while avoiding the complexity of needing to fully reconstruct a transaction history, even in case of extensive transaction dependencies [33].

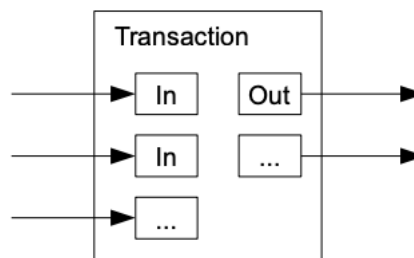


Figure 6. Multiple Inputs and Outputs within a Transaction

Source: [33].

Figure 7 shows the difference between traditional banking privacy model that is achieved by restricting the access to transaction details and blockchain privacy model that is maintained by keeping public keys anonymous, revealing only transaction amounts and not identities. It looks similar to stock exchanges where trade details are public, however parties remain anonymous. To enhance privacy, it is recommended to use a new key pair for each transaction, however multi-input transactions can still link inputs to a single owner [33].

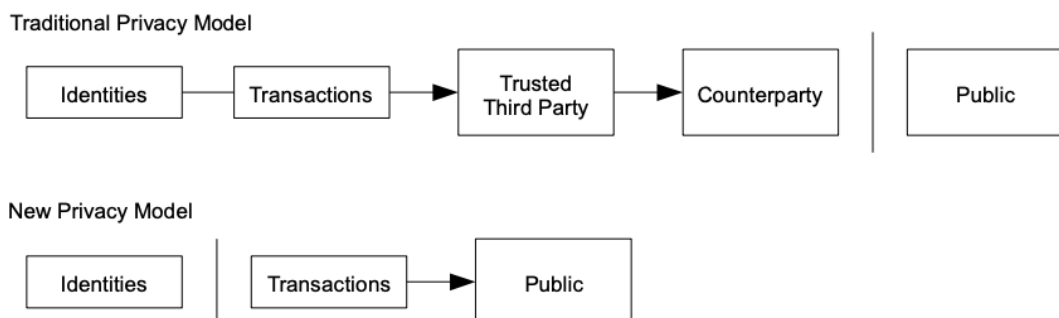


Figure 7. Difference in Privacy Models

Source: [33].

At the end of the article Nakamoto describes a situation when a protentional attacker tries to generate an alternative chain faster than the honest chain. He calculates the probability of the protentional attacker reaching breakeven or catching up with the honest chain using the following formula [33]:

$$q_z = \begin{cases} 1 & \text{if } p \leq q \\ \left(\frac{q}{p}\right)^z & \text{if } p > q \end{cases} \quad (1)$$

Where:

p – probability that a honest node discovers the next block

q – probability that the attacker finds the next block

q_z – probability the attacker will ever catch up from z blcoks behind

Assuming that $p > q$, the probability of the attacker catching up decreases exponentially with the amount of blocks the need to surpass. To make sure a transaction can't be altered by a protentional attacker the recipient waits until the transaction is included in a block followed by z additional blocks then the recipient generates a new key pair and provides the public key shortly before signing to prevent the attacker from preemptively preparing a chain of blocks. Surely, the attacker aims to deceive the recipient by working secretly on a parallel chain with an alternative transaction, at the same time the recipient relies on the average block time to estimate the attacker's progress modeled by a Poisson distribution with expected value (Formula 2) [33]:

$$\lambda = z \frac{q}{p} \quad (2)$$

To determine the probability that the attacker manages to catch up the Poison distribution is calculated for each possible level of progress the attacker might have achieved and then multiply this by the probability of catching up from that progress level (Formula 3) [33]:

$$\sum_{k=0}^{\infty} \frac{\lambda^k e^{-\lambda}}{k!} \begin{cases} \left(\frac{q}{p}\right)^{(z-k)} & \text{if } k \leq z \\ 1 & \text{if } k > z \end{cases} \quad (3)$$

Where:

p – propability that a honest node discovers the next block

q – probability that the attacker finds the next block

z – additional blocks

k

– the number of blocks the attacker has managed to mine in alternate chain

Reorganizing the expression to avoid calculating the sum of the distribution's infinite tail (Formula 4) [33]:

$$1 - \sum_{k=0}^z \frac{\lambda^k e^{-\lambda}}{k!} \left(1 - \left(\frac{q}{p} \right)^{(z-k)} \right) \quad (4)$$

Summarizing the mentioned above the blockchain technology looks well advanced and secure. It offers e-money to its users for taking a part in the process, the ones with fraudulent intentions can “enjoy” getting coins legally as it is designed to be more profitable than to cause damage there. There is no central authority that controls the process and issues coins. Common issues like double – spending is solved. However, according to some authors the unique model has its cons such as: lack of privacy, security model as the private key is the only security instrument to protect assets related to a user's account, limited scalability due to reduction of processing speed, high costs as difficulty of hash puzzles increases so it requires more and more advanced technologies, hidden concentration due to a possibility of a small group with the advanced technologies to abuse the power they have and to ignore special transactions or to discriminate against users, legal inadmissibility due to a new way of looking at ownership and the legal status of Bitcoin and other currencies, users inadmissibility as the blockchain legal case rises up uncertainty in users and the result of it is unwillingness to use the technology [36].

Additionally, banks, cryptocurrency exchanges and brokers usually require identification documents from users as a part of their compliance with regulations such as Anti-Money Laundering (AML) and Know Your Customer (KYC) laws. Obviously, dealing with brokers or exchange platforms simplify dealing with cryptocurrencies, however it simply kills at least two birds with one stone – decentralization as the broker or the platform become responsible for all the transactions and, of course, anonymity due to the need to show identification documents to be able to buy and sell cryptocurrencies. At the same time dealing

directly with Bitcoin remains a complex task for the majority of users, therefore brokers take the lead eliminating the advantages of electronic money. More than that such brokers and exchange platforms have even applied unprecedented sanctions on a state that is Russia in 2022 and 2023. So, Binance – one of the biggest exchange platforms simply decided to exit Russian market with a sale to another company in 2023 leaving restriction for Russian passport holders [37]. Another platform – the biggest crypto broker – Coinbase went even further and decided to block up to 25000 wallets related to Russia in 2022 [38].

1.3 Studies on Cryptocurrency Market

Cryptocurrency market looks more and more attractive, as it offers fast and huge profit for its investors. The market is much «younger» than others, and due to it can be rather unstable plus, not to mention, its dependency on the media – for example Elon Musk who replaced X's application logo with Shiba Inu dog increased the price of so-called dogecoin by 30% by doing just that [25]. This also verifies the article «How Elon Musk's Twitter activity moves cryptocurrency markets» by Lennart Ante where the author concludes that Elon Musk's posts in twitter (now X) influence the cryptocurrency market significantly, however the persistence of this «Musk Effect» is uncertain as it also raises concerns about investor protection due to the large price volume movements caused by a single post. The author highlights the need for protentional regulatory measures, such as requiring influencers to disclose their holdings in cryptocurrencies they comment on [46]. No doubt, some of the cryptocurrency, like the one mentioned above, don't even look serious enough to invest even a penny in them, as they rather look like a joke than a real asset, there is even a term does exist for them – «meme coin» [26]. More than that, according to CoinGekko over 50% of existing 24000 coins since 2014 had failed and considered «dead». Figure 8 displays the number of cryptocurrencies that failed each year since 2014 [27].

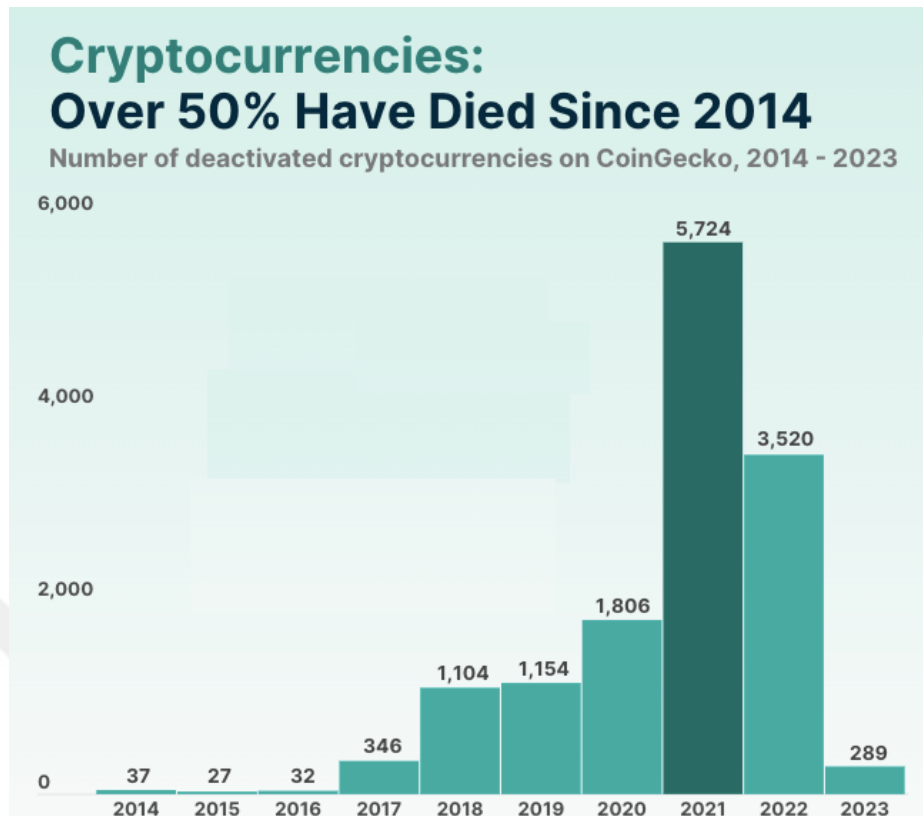


Figure 8. The Amount of Failed Cryptocurrencies

Source: [27].

According to the figure 8 more than 8000 cryptocurrencies have failed in 2021 and 2022 combined. Those 2 years were the first after the COVID-19 pandemic, so it means the bullish expectations during it did not meet the reality. Cryptocurrencies that considered failed get deactivated and removed from the platforms for following reasons: no trading activity within the last 30 days, projects are fraudulent, or rug pull, projects get deactivated upon owner's request [27]. This fact might mean that the interest in cryptocurrencies is temporary.

Deceased national currencies also exist, however usually there's a chance to replace demonetized currencies with the new ones and when it comes to cryptocurrencies there is never such an option – that's one of the advantages of having a central authority [91].

It is essential to understand the nature of the market to be able to forecast it and to find out if it is no more than another financial pyramid or the future of money. Understanding the nature also helps to forecast possible risks so it can get evaluated before it appears.

In the article "Impact of Macroeconomic News, Regulation, and Hacking Exchange Markets on the Volatility of Bitcoin" by Stefan Lyócsá, Peter Molnár, Tomáš Plíhal, and Mária Širanová, the authors examine the factors influencing Bitcoin's volatility, with a particular focus on the impact of announcements. They find that Bitcoin's volatility increases significantly ahead of regulatory announcements, especially those covered by major outlets like the Financial Times. This is consistent with prior studies suggesting that regulation plays a crucial role in cryptocurrency price movements. Additionally, the authors find that Bitcoin's volatility is strongly affected by hacking attacks on exchanges, especially in terms of jump volatility, which involves abrupt price changes. In contrast, macroeconomic news has little effect on Bitcoin's volatility, except for forward-looking indicators like the consumer confidence index, suggesting that Bitcoin is more influenced by announcements specific to the cryptocurrency market rather than general economic news [7].

In the study "Cryptocurrency reaction to FOMC Announcements: Evidence of Heterogeneity Based on Blockchain Stack Position" by Shaen Corbet et al., the authors found that currency-based digital assets (e.g., Bitcoin) react similarly to traditional financial assets to monetary policy announcements such as those from the Federal Reserve. These assets are influenced by broader FIAT market conditions. However, protocol-based assets (like Ethereum) show a different reaction, sometimes even moving in the opposite direction to currency-based assets in response to similar announcements. The study also highlights the role of ICO-related announcements, where speculative movements and informational overshooting can cause significant price changes, especially in the application layer of the blockchain [8].

In the article "Expectations of Macroeconomic News Announcements: Bitcoin vs. Traditional Assets" by Ivan Mužić and Ivan Gržeta, the authors examine how U.S. macroeconomic news impacts Bitcoin compared to traditional assets like gold, the S&P 500, and Treasury notes. They find that while macroeconomic news significantly affects Bitcoin's returns, it has little impact on volume or volatility. Bitcoin's response is similar to two-year Treasury notes, but not to gold, challenging the idea of Bitcoin as "digital gold." The study highlights Bitcoin's riskier, emotion-driven market, suggesting the need for regulation to protect retail investors due to its high volatility [11].

Igor Makarov and Antoinette Schoar in their article study price formation and arbitrage in the cryptocurrency market and conclude that the arbitrage spreads are much for exchanges across countries that differ than within the same one. As well, exchange rates between different currencies show small deviation on all exchanges. Those result display that the main factors that contribute to market segmentation are the lack of regulatory oversight along with capital control [9].

More than that, mentioned above so-called «Black swans» might otherwise have a positive impact on cryptocurrency market like recent COVID-19 pandemic [12]. Cryptocurrencies are well known for being an extremely complex and highly volatile [15]. In fact, when other markets were struggling due to economy shut down resulting in significant losses cryptocurrencies were otherwise gaining value [13]. As in March 2020 the price of one Bitcoin has dropped more than 50% from \$10000 to \$4000, however already in February 2021 it was around \$44000 [14]. Analyzing such a phenomena Mrestyal and Maaz Khan in their article conclude that all cryptocurrencies (Bitcoin, Ethereum and Litecoin used in the article) exhibit volatility clustering, as well as fat tail phenomena with leverage effects in both (before and after) the period of COVID-19 pandemic. More than that they claim that conditional volatility of the mentioned above cryptocurrencies also affected by the recent news (ARCH effect) and by old news as well (GARCH effect) [14].

According to Hashemi Joo and others in their article «Announcement effects in the cryptocurrency market» significant abnormal returns can be observed on the day of the news event, however cumulative abnormal returns continue to diverge for several days after the event, indicating that it takes time for the market to fully incorporate the news into prices. Cumulative abnormal returns extending up to six days after the event therefore the information in the cryptocurrency market is absorbed slowly. Negative news results in larger cumulative abnormal returns compared to positive news, displaying stronger reaction to negative events. Traders and investors might still find trading opportunities by entering positions even after major news announcements due to the market reaction to news that can be prolonged and more pronounced for negative events [39].

Similar results Emrah Öget declares in his article «The effect of positive and negative events on cryptocurrency prices» where he finds that negative events have a

stronger impact on cryptocurrencies than positive. The article suggests investors to consider even quitting the market after negative news are announced to avoid greater losses [40].

Gourang Aggarwal and others in their article «Understanding the Social Factors Affecting the Cryptocurrency Market» indicate a weak correlation between social factors and cryptocurrency market trends suggesting that traditional methods of analyzing the stock market may not be applicable to the cryptocurrencies market due to different nature of this market with different characteristics and markets behavior. The article also declares that various news stories may influence market fluctuations either short or long term the overall effect of media on cryptocurrency prices is not yet clear due to limited data and emerging nature of the market itself [41].

The study «Impact of public information arrivals on cryptocurrency market: a case of twitter posts on ripple» published by Samet Gunay by using Markov regime switching regression analysis examined the impact of Ripple's (one of the most popular cryptocurrencies) Twitter (now X) announcements on its price under different market conditions. The result declares that in a bull market public information positively influenced Ripple's price, however in a bear market these announcements were not enough to counteract the downward trend [42].

Shaen Corbet and others share surprising results in their article «The volatility generating effects of macroeconomic news on cryptocurrency returns». The results declare the absence of significant relationship between GDP announcements and Bitcoin returns due to the reduced number of observations since GDP data is released quarterly. The study also finds that news related to durable goods and unemployment otherwise significantly affect Bitcoin returns and even CPI doesn't show statistically significant relationships [43].

Minjung Park and Sangmi Chain in their article «The Effect of Information Asymmetry on Investment Behavior in Cryptocurrency Market» found that many traders base their trading decisions more on sentiment rather than on concrete information about cryptocurrencies they buy. The cryptocurrency market itself exhibits a high degree of information asymmetry compared to the stock market what means that privileged information has a stronger influence there contributing to higher risk and market inefficiency. The article suggests that to manage sentiment-based

investments and reduce price volatility as well as proper regulation and public information dissemination are necessary [44].

Anamika Kulbhaskar and others in their article «Do News Headlines Matter in the Cryptocurrency Market? » came a conclusion that news sentiment significantly impact cryptocurrency returns. Notable result of the study that cryptocurrencies respond differently to sentiment due to their diverse and heterogeneous nature and that sentiment has a stronger effect on younger, smaller and more volatile cryptos [45].

Stuart Hyde and others compare cryptocurrency market to Forex in their article «News Sentiment in the Cryptocurrency Market: An Empirical Comparison with Forex». The don't agree with the result that cryptocurrencies react more on negative news, otherwise the authors declare that particularly Bitcoin shows a stronger response to positive news and even ignores negative ones. They underline that negative news has a delayed effect on Bitcoin and even sometimes positive effect. They add that Bitcoin's trading volume increases with news, however its volatility remains largely unaffected by news, except during so-called bubble periods. The authors find that traditional currencies (Forex) react immediately and significantly particularly to economic news, and negative news tends to decrease exchange rate returns while positive increase them, what is quite logical, at the same time both types of news lead to increased trading volume [47].

The research by Tiam Bakhtiar, Xiaojun Luo, and Ismail Adelopo explores the factors influencing cryptocurrency prices, with a focus on network effects and social media influence. They found that variables such as the number of active wallet addresses, transactions, and circulating supply significantly impact cryptocurrency prices. These factors could amplify the effects of announcements or other external events, indirectly reflecting the announcement effect on prices. Additionally, the study underscores the influence of social media, specifically X (Twitter) sentiment and Reddit subscribers, suggesting that online sentiment and social networks play a key role in determining cryptocurrency values. Future research could integrate these elements into more comprehensive models to better understand market dynamics [16].

However, banks might even face bankruptcy investing their money wrong. Carlos Esparcia, Ana Escribano and Francisco Jareño conclude in their article that the USD Coin stablecoin may have played a significant role in the recent collapse of the

Silvergate bank [10]. So, it means even professional investors can easily fail investing in cryptocurrencies.

1.4. Announcement Effect

According to Oxford Reference announcement effect is the effect occurs even before the announced change in policy takes place. An example of it can be promised by the government future tax reduction that may lead to an instant increase in consumer spending. The dictionary underlines that announcements can produce such effects only if their maker has credibility [29]. However, the world is living in the era of the internet when a certain announcement might be faked, to come from not even a trustworthy source claiming opposite or the real source might be hacked providing fake information, surely these days well-known quote – «He who controls information controls the world. » is as relevant as never before. According to Investopedia the announcement effect indicates the role that social media, company headlines, news play in decisions made by investors. The source comes up with an example of stock prices that can quickly move up and down upon release of a positive or negative story. As well as government issued announcements, economic data releases, guidance from the Federal Reserve can also play a significant role in moving broader markets and investor attitude. The announcement effect supposes that behavior of systems such as financial markets or people can simply change by announcing a future policy change or disclosure a newsworthy topic [30]. Basically, even publishing a balance sheet that, for example, all European companies with limited liability – no matter if private or public – are required to publish, can have an announcement effect. Black swans can also have a significant announcement effect. It fair to remember the announcement of the pandemic of COVID-19 that resulted immediate stock market crashes, unprecedented government intervention, shift in investor behavior.

The announcement effect of an ordinary market can be caused by:

- Corporate announcements with their earnings reports, mergers, acquiritors, dividends, buybacks, management changes, new product launches
- Economic data releases such as interest rate decisions, inflation data, employment reports, GDP growth rates
- Political events such as elections, legislation, policy changes, geopolitical events

- Unpredictable events (Black swans) such as natural disasters, pandemics, terrorist attacks
- Central bank actions such as quantitative easing or tightening, monetary policy statements
- Legal and regulatory decisions such as court rulings, regulatory approvals or denials

However, when it comes to cryptocurrency market all causes mentioned above might have less significant impact than for example a change of a logo of Twitter (now X) to an image of Shiba Inu (a breed of a dog and a logo of dogecoin) made by Elon Musk (the current owner of X) that increased the price of dogecoin by 30% [31]. And indeed, it is rather bizarre to imagine anything like this when it comes to stocks – why would a company CEO advertise another company? It might look strange and might even arouse interest in U.S. Securities and Exchange Commission due to inside trading restrictions and according to the Securities Exchange Act of 1934, specifically through Rule 10b-5. As well as ordinary currency, but when it comes to cryptocurrencies such actions are possible. If dogecoin doesn't seem to be known and big enough there is another example took place on July 27 when the former US president Donald Trump led the biggest Bitcoin conference of the year in Nashville state Tennessee where in his speech he said that in case he gets re-elected in November 2024 he will make the US «crypto capital of the planet and the Bitcoin superpower of the world». Surely right after this announcement the price of Bitcoin jumped up to \$70000 USD (the highest level in more than six weeks) and a few days later dropped back to \$62000 USD [32].

It's fair to conclude that the announcement effect can influence every possible market, especially these days when the information comes first and only sometime later, we realize if it was real or fake. It is also fair to assume that cryptocurrencies are a good instrument for manipulations and therefore speculations - knowing the fact the market gets easily influenced by the announcement effect without any negative consequences - allows opinion leaders, public persons and so on to make huge profit out of it, as they know exactly when they will make a post or when they give a speech and even if their capital is not this great they can easily collaborate with others so it can easily be called inside trading that is restricted by the law.

1.5. Purpose of the Study

The literature analysis indicates that Bitcoin is indeed the first widely successful cryptocurrency, though the underlying concept of digital currency predates it. Bitcoin became the most popular cryptocurrency due to the unique economic incentives offered through its blockchain system, despite not being the first to introduce the idea. The cryptocurrency market remains relatively young and smaller compared to the global stock market, with many cryptocurrencies failing or being fraudulent, adding significant risk for investors. Cryptocurrencies, unlike traditional currencies, are not true investments as they lack liquidity and are often treated more like stocks.

The legal status of cryptocurrencies is still unclear in many countries, making it difficult to define ownership and enforce laws around theft. The market is also prone to manipulation, as public figures can influence prices through announcements, creating speculative opportunities. Cumulative abnormal returns after events tend to diverge for several days, with negative news causing stronger reactions, highlighting the market's volatility and lack of trust. While traders may find opportunities even after major news, some experts suggest exiting after negative announcements.

Despite blockchain's security advancements, the technology still faces limitations. The analysis concludes that forward contracts could reduce risks and help cryptocurrencies evolve into more stable, functional currencies rather than speculative assets.

The following results from the literature review align with the study goals:

1. Exploring the History and Evolution of the Cryptocurrency Market: In the article "Impact of Macroeconomic News, Regulation, and Hacking Exchange Markets on the Volatility of Bitcoin" by Lyócsá et al., the authors examine the regulatory environment and external factors like hacking that have shaped Bitcoin's market dynamics. This explores the evolution of the cryptocurrency market and the factors contributing to its popularity. Makarov and Schoar's study on price formation and arbitrage in the cryptocurrency market also touches on factors like market segmentation due to a lack of regulation, which helps understand the market's historical evolution in terms of regulatory impact.

2. Analyzing the Influence of Announcements on Cryptocurrency Prices and Market Behavior: The study by Hashemi Joo et al., "Announcement effects in the cryptocurrency market", suggests that announcements result in significant abnormal returns and that cumulative abnormal returns continue to diverge for several days, showing that the market absorbs the news slowly. This demonstrates the impact of various announcements on cryptocurrency prices. Similarly, Gunay's work on Ripple's Twitter announcements demonstrates how public information, like social media posts, influences cryptocurrency price movements under different market conditions, highlighting how external announcements shape market behavior.
3. Forecasting Cryptocurrency Price Movements: The study by Shaen Corbet et al. on cryptocurrency reactions to FOMC announcements highlights the heterogeneity in responses to such macroeconomic events. This suggests that predictive models should account for different reactions across cryptocurrencies, which is relevant to forecasting price movements. Mrestyal and Maaz Khan's analysis of cryptocurrency volatility before and after the COVID-19 pandemic, including the ARCH and GARCH effects, offers insights into how past news events affect future price movements, which supports the idea of forecasting cryptocurrency price movements.
4. Assessing the Stability and Volatility of the Cryptocurrency Market: Lyócsá et al.'s finding that Bitcoin's volatility is heavily impacted by regulatory announcements and hacking events underscores the importance of understanding volatility and stability in response to specific external events. Mrestyal and Maaz Khan also find that cryptocurrencies exhibit volatility clustering and fat-tail phenomena, particularly during crisis events like the COVID-19 pandemic, which is directly relevant to assessing market volatility over time.
5. Understanding the Impact of External Factors on Cryptocurrency Price Movements: The study by Minjung Park and Sangmi Chain explores the impact of information asymmetry and sentiment-based investments on the cryptocurrency market, showing how market sentiment and external factors, such as social media and privileged information, influence price movements. The research by Bakhtiar et al. emphasizes the role of network effects and social

media sentiment in influencing cryptocurrency prices, illustrating how external factors affect market behavior.

6. Providing Actionable Insights and Recommendations for Investors: According to Öget's study, negative events have a stronger impact on cryptocurrencies than positive ones, suggesting that investors need to consider adjusting their strategies based on the nature of announcements, providing actionable insights for investors to navigate market volatility. Similarly, Hashemi Joo's article suggests that the market's reaction to news events can be prolonged, especially for negative announcements, highlighting opportunities for investors to enter the market even after an announcement, which is relevant for offering actionable recommendations.

The potential contributions of this study, building upon existing literature, are as follows:

- a. New Methodological Approach: This study introduces a comprehensive analysis of the long-term effects of public announcements on cryptocurrency markets, particularly focusing on both positive and negative news events. While prior studies, such as those by Hashemi Joo et al. and Öget, mainly analyze short-term abnormal returns, this research examines how market reactions evolve over several days after announcements. This approach provides deeper insights into how market sentiment is absorbed over time, especially for stable cryptocurrencies like Bitcoin and Ethereum, as well as for more volatile ones like Dogecoin and Ripple.
- b. Incorporation of Social Media Sentiment: Extending the work of Tiam Bakhtiar et al. and Gunay, this study explores the influence of social media sentiment—especially from platforms like X (formerly Twitter)—on cryptocurrency prices. By investigating the role of sentiment in shaping price movements across various cryptocurrencies, particularly smaller ones, this research enhances our understanding of the impact of social media on market behavior. This expands Gunay's analysis of Ripple and provides new insights into how social media sentiment interacts with price changes in volatile markets.
- c. Verification of Previous Findings on Volatility and Announcements: This study re-examines volatility clustering, as observed by Mrestyal and Khan, specifically

focusing on how macroeconomic and cryptocurrency-specific announcements impact price movements. By confirming the limited effect of broader economic news (e.g., GDP data, consumer confidence) on cryptocurrency markets, this study supports previous findings that cryptocurrency prices are more influenced by sector-specific announcements, particularly those related to regulations or technological developments.

- d. **Exploration of Market Maturity:** In line with the studies by Corbet et al. and Makarov & Schoar, this research explores how the increasing maturity of the cryptocurrency market—driven by growing user bases and market participation—has reduced the sensitivity of major cryptocurrencies like Bitcoin and Ethereum to announcements. The study investigates whether market size and participant diversity have made these currencies more stable and less responsive to announcements, particularly those from regulatory bodies and social media influencers.
- e. **Risk Analysis in the Cryptocurrency Market:** Building on the findings of Esparcia et al. and Mužić & Gržeta, this study assesses emerging risks in the cryptocurrency market, particularly those associated with AI-driven cyberattacks. By examining these risks and their potential impact on market stability, this research contributes to a better understanding of vulnerabilities within the cryptocurrency ecosystem. It offers a forward-looking perspective on how AI could shape market dynamics and security concerns in the cryptocurrency space.
- f. **Understanding the Impact of Black Swan Events:** This study examines the impact of Black Swan events, similar to the findings by Mrestyal and Khan regarding the COVID-19 pandemic's effects on cryptocurrency markets. By exploring how cryptocurrencies, particularly Bitcoin and Ethereum, behave during significant global crises or economic upheavals, this research adds to the literature suggesting that cryptocurrencies may serve as a safe haven during extreme geopolitical, technological, or financial instability. The analysis helps to identify the resilience of cryptocurrencies during such events and how they may react to unforeseen shocks in the future.

SECOND PART

DATA COLLECTION AND METHODOLOGY

2.1 Data Collection

Four cryptocurrencies are selected for the following research. All of them as for 26 November 2024, are listed in top 10 cryptocurrencies based on market cap. The first one is Bitcoin itself that is considered the most valuable and the strongest cryptocurrency, Ethereum with more than \$400 billion USD market cap, XRP with its \$78 billion USD market cap and Dogecoin that is considered one of the top performing cryptocurrencies due to Elon Musk's rise of political influence and the fact he used to "promote" it via posting tweets on his account[48, 49].

All four selected currencies have different market capitalization, the prices of two biggest ones (Bitcoin, Ethereum) differ by an order of magnitude from the other two (Dogecoin, Ripple (XRP)), three of them are considered the most mentioned cryptocurrencies on twitter (now X) (Bitcoin, Ethereum, Dogecoin) at the same Ripple (XRP) is less influential [92]. All selected currencies have designed with different purposes:

- Bitcoin aims to be a store of value and digital currency.
- Ethereum is a decentralized platform for decentralized applications and smart contracts.
- Dogecoin started as a meme but has become a fun way to exchange small amounts.
- XRP focuses on facilitating fast and cheap cross-border payments.

Considering the difference in purposes, the influential level, market capitalization, and other distinguishing factors, this variety of cryptocurrencies should indeed be sufficient to achieve the research goals. By incorporating both major players like Bitcoin and Ethereum, and smaller altcoins with niche purposes or communities, it should be possible to observe how different triggers (market sentiment, regulatory events, technological developments, black swans) affect various segments of the cryptocurrency market. Only four cryptocurrencies were selected due to three of them

being considered the most mentioned cryptocurrencies on the social media (Bitcoin, Ethereum, Dogecoin) along with the one that is less influential Ripple (XRP) [93].

However, all of them have established histories with strong price movements tied to events like regulatory rulings, celebrity endorsements, and technological advancements, making them ideal for studying the announcement effect. Other coins may not exhibit the same level of volatility, media coverage or being way too new, limiting their usefulness for this specific research. These four provide enough data and relevant market responses to draw meaningful insights.

It is fair to consider Bitcoin, Ethereum and XRP as real payment methods, however Dogecoin was created and designed as a joke and to make fun of the speculation in cryptocurrencies, therefore a hypothesis arises that Dogecoins success is only based on announcement effect, as there are quite many cryptocurrencies that are designed for fun (there is even a term – Meme Coins), but they have never been promoted as much as Dogecoin [50]. It is also fair to notice that investors understanding the risks usually avoid not serious assets, however for Dogecoin it looks an entirely different story.

The decision to avoid cryptocurrencies that are linked to the US Dollar is based on the fact they are designed to maintain a 1:1 value with the United States Dollar. Consequently, all the announcements that affect US Dollar directly affect the cryptocurrency that is linked to it. Dollar in this case minimizes price volatility, makes these cryptocurrencies popular for trading, payments and to store. The primary concern of the research is to focus on high volatile assets that are not linked to stable national currencies, but that are independent or linked to other cryptocurrencies to find out the impact of the announcement affect. Additionally, it is essential to find out if there is a correlation between cryptocurrency prices, despite the fact if they are linked to each other or not.

The final list of the selected cryptocurrencies is presented in the table 2.

Table 2. The List of Selected Cryptocurrencies

Bitcoin (BTC)	Ethereum (ETH)	Ripple (XRP)	Dogecoin (DOGE)
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Historical exchange rate secondary data is sourced from Investing.com and covers the period from 03 June 2017 to 27 October 2024, for all the selected

cryptocurrencies. It includes more than 2700 daily price observations. This period encompasses major and minor announcements listed below in the Table 3, the number of observations is sufficient for forecasting prices and for the statistical analysis as well. All the exchange rates are in US Dollar [51, 52, 53, 54].

Major and minor announcements are categorized as positive or negative based on their impact on the price change of the cryptocurrencies mentioned in them. The categorization also considers their effect on other markets, the type of news, and the period from 12 July 2019 to 27 July 2024. Each announcement in this study had a significant impact on either a specific cryptocurrency, another, or on all of them combined. The analysis focuses on how these events—whether regulatory, technological, or market-related—shaped investor behavior and price movements across the selected cryptocurrencies. The sources of the announcements are BBC News, CNN, Reuters, The New York Times, The Wall Street Journal, Forbes, Bloomberg, The Financial Times and Twitter (now X) itself. The list of the selected announcements is presented in the table 3.

Table 3. The List of Selected Announcements

№	Date	Positive/negative for the crypto market	Type of news	Event
1	27.07.2024	Positive	Public speech of an opinion leader	Donald Trump pledged to make the U.S. the "crypto capital of the planet" if he wins the 2024 election, proposing to end the "war on crypto," establish a federal Bitcoin reserve, and promote Bitcoin mining and transactions.
2	13.07.2023	Positive	Regulatory action	A U.S. judge ruled XRP was not a security on exchanges, causing XRP to surge and boosting positive sentiment in the crypto market.
3	07.11.2022	Negative	Bankruptcy of a cryptocurrency exchange FTX	Binance announced plans to sell its entire FTT holdings after criticism of FTX CEO Sam Bankman-Fried's regulatory stance. This caused FTT's price to plummet by 19%.
4	24.02.2022	Negative/Positive	Black swan	Russo-Ukrainian conflict
5	12.05.2021	Negative	Tweet of an opinion leader	Tweet: Musk announced Tesla would stop accepting Bitcoin over environmental concerns. Impact: Bitcoin's price dropped sharply but later recovered amid talks on sustainable energy.
6	28.04.2021	Positive	Tweet of an opinion leader	Tweet: Musk referred to himself as "The Dogefather" ahead of his SNL appearance.

				Impact: Dogecoin saw a surge in interest and a short-term price spike.
7	01.04.2021	Positive	Tweet of an opinion leader	Tweet: Musk announced SpaceX would put a "literal Dogecoin on the literal moon." Impact: Dogecoin's price surged, boosting its popularity.
8	08.02.2021	Positive	Tweet of a company	Tweet: Tesla announced a \$1.5B Bitcoin investment and acceptance as payment. Impact: Bitcoin surged to a then all-time high of \$44,000.
9	29.01.2021	Positive	Tweet of an opinion leader	Tweet: Musk added “#Bitcoin” to his Twitter bio. Impact: Bitcoin's price surged to new all-time highs.
10	22.12.2020	Negative	Regulatory action	The SEC's lawsuit against Ripple over XRP as an unregistered security caused XRP's price to plummet and raised broader concerns about crypto regulation.
11	20.12.2020	Positive	Tweet of an opinion leader	Tweet: Musk tweeted, "One word: Doge." Impact: Dogecoin's price spiked significantly.
12	12.03.2020	Negative/Positive	Black swan	The COVID-19 pandemic caused a market crash, with Bitcoin dropping over 50% in a day, revealing its strong correlation with traditional markets in crises.
13	11.07.2019	Negative	Tweet of an opinion leader	Tweet: Trump called Bitcoin volatile and baseless. Impact: His criticism hinted at stricter U.S. regulation, briefly dipping Bitcoin's price before recovery.

2.2 Research Methodology

The research starts with the data collection process. As it was mentioned in the data collection paragraph (2.1) – secondary data was collected from Investing.com that covers the period from 03 June 2017 to 27 October 2024. However, during the observation process two errors have been found in the dataset and fixed before applying statistical methods. The first one is missing date – 17 April 2024 with XRP price figure 9 [53].

XRP Historical Data ^①

Time Frame

Daily

Download

04/13/2024 - 04/20/2024

Date ↕	Price ↕	Open ↕	High ↕	Low ↕	Vol. ↕	Change % ↕
Apr 20, 2024	0.5288	0.5030	0.5299	0.4987	563.49M	+5.19%
Apr 19, 2024	0.5028	0.5025	0.5106	0.4677	1.10B	+0.04%
Apr 18, 2024	0.5025	0.4884	0.5052	0.4858	685.30M	+1.21%
Apr 16, 2024	0.4965	0.4976	0.5017	0.4771	830.95M	-0.22%
Apr 15, 2024	0.4976	0.5034	0.5187	0.4815	1.05B	-1.16%
Apr 14, 2024	0.5034	0.4782	0.5072	0.4643	1.35B	+5.26%
Apr 13, 2024	0.4783	0.5470	0.5488	0.4312	1.89B	-12.57%
Highest: 0.5488	Lowest: 0.4312	Difference: 0.1176	Average: 0.5014	Change %: -3.3233		

Figure 9 Ripple (XRP) Prices with A Missing Date – 17 April 2024

Source: [53].

To fix it average value was created for the date 17 April 2024 using the following formula:

$$Average = \frac{\sum(\text{values in the range})}{\text{count of values in the range}} \quad (5)$$

Using the formula (5)

$$XRP \text{ price on } 17.04.2024 = \frac{XRP \text{ price on } 18.04.2024 + XRP \text{ price on } 16.04.2024}{2} = \frac{0.503 + 0.497}{2} = \frac{1}{2} = 0,500$$

Consequently, in the dataset XRP price on 17.04.2024 is equal 0,500 and this value is used in the calculations.

The second error is the price of Dogecoin on 15 January 2020 that is an extreme outlier and is displayed on the figure 10 [54]. Simultaneously, other sources, for example coinmarketcap.com displays a more realistic value that is \$0.002468 [55].

Dogecoin 0.403576 +0.002545 (+0.63%)								
Jan 21, 2020	0.002389	0.002467	0.002513	0.002354	1.62B	-3.14%		
Jan 20, 2020	0.002467	0.002423	0.002478	0.002375	1.66B	+1.82%		
Jan 19, 2020	0.002423	0.002503	0.002524	0.002382	1.92B	-3.20%		
Jan 18, 2020	0.002503	0.002478	0.002506	0.002441	1.94B	+0.94%		
Jan 17, 2020	0.002479	0.002323	0.002497	0.002309	2.16B	+6.74%		
Jan 16, 2020	0.002323	0.148228	0.184558	0.002290	1.87B	-98.43%		
Jan 15, 2020	0.148228	0.002356	0.180909	0.002328	2.21B	NaN%		
Jan 14, 2020	0.002356	0.002161	0.002372	0.002155	2.38B	+9.04%		
Jan 13, 2020	0.002161	0.002205	0.002233	0.002157	1.51B	-2.02%		
Jan 12, 2020	0.002205	0.002179	0.002228	0.002147	1.63B	+1.20%		
Jan 11, 2020	0.002179	0.002207	0.002240	0.002164	1.73B	-1.31%		
Jan 10, 2020	0.002208	0.002138	0.002209	0.002090	1.71B	+3.29%		

Figure 10. Dogecoin Prices With an Extreme Outlier on 15 January 2020

Source: [54].

To fix it the same formula (5) was used:

$$\text{Dogecoin price on 15.01.2020} = \frac{\text{Dogecoin price on 16.01.2020} + \text{Dogecoin price on 14.01.2020}}{2} = \frac{0.002323 + 0.002356}{2} = \frac{0.004679}{2} \approx 0,002340$$

Therefore, in the dataset Dogecoin price on 15.01.2020 is equal 0,002340 and this value is used in the calculations.

The secondary data with the selected announcements and their dates, as it was mentioned in the data collection paragraph (2.1), were collected from BBC News, CNN, Reuters, The New York Times, The Wall Street Journal, Forbes, Bloomberg, The Financial Times and Twitter (now X).

To avoid skewed results or biased models it is necessary to standardize the exchange rate data collected for all the currencies. Due to the significant exchange rate difference, for example, as for, 27.10.2024 the price of 1 Bitcoin is more than \$60000 USD, at the same time, the price of 1 Dogecoin or 1 Ripple (XRP) is less than \$1 USD.

To standardize the data the following formula is used [56]:

$$z = \frac{(x - \mu)}{\sigma} \quad (6)$$

Where:

x - the data value

μ - the mean value of a variable

σ - the standard deviation

To calculate the mean formula (5) is used.

The standard deviation measures the amount of variation or dispersion in a dataset and indicates how spread out the data points are around the mean value. To calculate the standard deviation the following formula is used [57]:

$$\sigma^2 = \frac{1}{N-1} \sum_{i=0}^{N-1} (x_i - \mu)^2 \quad (7)$$

Where:

N - total number of data points

μ - the mean value of a variable

x_i - each data point

The next step is to find out if there is a correlation between selected cryptocurrencies (Bitcoin, Ethereum, Dogecoin and Ripple (XRP)). It is essential as a positive or negative announcement that touches one cryptocurrency can automatically affect other ones that might be linked to it. As long as there are only four cryptocurrencies and there is no clear resulting factor, regression analysis might be ineffective and to display inaccurate results. Additionally, cryptocurrencies are considered extremely high volatile assets with their constantly changing prices due to speculative factors. Cryptocurrencies might move within complex nonlinear relationships: between each other and/or with other assets as well. The market is rather emotion-driven therefore cryptocurrencies are heavily influenced by investor behavior and speculative news. Regression models perform poorly with data where market structures frequently shift in general. Also, with only four cryptocurrencies multicollinearity could occur, consequently regression in this case faces challenges in terms of interpretability and stability of the coefficients, so without applying additional methods like principal component analysis (PCA) that reduces the number of correlated predictors the result is rather inaccurate especially considering the lack of the clear resulting factor as well. As a result, only correlation analysis will be used to determine the correlation between selected variables.

To determine the correlation between selected variables a correlation matrix will be calculated. The matrix shows the pairwise correlation coefficients between variables in a dataset where each cell in this matrix contains the correlation coefficient which measures the linear relationship between two variables. In case of four variables (X_1, X_2, X_3, X_4), the correlation matrix is a 4×4 symmetric matrix that has the following structure [58]:

$$R = \begin{bmatrix} 1 & r_{X_1X_2} & r_{X_1X_3} & r_{X_1X_4} \\ r_{X_2X_1} & 1 & r_{X_2X_3} & r_{X_2X_4} \\ r_{X_3X_1} & r_{X_3X_2} & 1 & r_{X_3X_4} \\ r_{X_4X_1} & r_{X_4X_2} & r_{X_4X_3} & 1 \end{bmatrix} \quad (8)$$

To calculate the correlation coefficient for every pair of variables (X_i, X_j) the following formula will be used:

$$r_{X_iX_j} = \frac{\sum(X_i - \bar{X}_i)(X_j - \bar{X}_j)}{\sqrt{\sum(X_i - \bar{X}_i)^2 \sum(X_j - \bar{X}_j)^2}} \quad (9)$$

Where:

X_i and X_j – individual values of the variables X_i and X_j

$\bar{X}_i$ and $\bar{X}_j$ – the means of X_i and X_j

$\sum(X_i - \bar{X}_i)(X_j - \bar{X}_j)$ – covariance between two variables that measures the degree two variables change together to

$\sum(X_i - \bar{X}_i)^2$ – variance of X_i

$\sum(X_j - \bar{X}_j)^2$ – variance of X_j

The next step is to find out the impact of the announcements by calculating the daily returns by using the following formula [59]:

$$R_t = \ln \left(\frac{P_t}{P_{t-1}} \right) \quad (10)$$

Where:

P_t – closing price of the asset on the day t

P_{t-1} – closing price of the asset on the previous day

For the forecasts Holt's Linear Trend Method will be used. The method extends simple exponential smoothing method to account for trends and has two components:

Level and Trend. Holt – Winters Seasonal Methods that extend Holt’s method and include seasonality won’t be used at the same time due to seasonality not being confirmed. Holt’s Linear Trend Method contains three key following formulas (11)(12)(13) [60]:

1. Level (Smoothed value at time t):

$$l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1}) \quad (11)$$

Where:

l_t – smoothed level at time t

α – level smoothing parameter ($0 \leq \alpha \leq 1$)

y_t – actual observation at time t

l_{t-1} – smoothed level at the previous time step

b_{t-1} – smoothed trend at the previous time step

2. Trend (Rate of change at time t):

$$b_t = \beta(l_t - l_{t-1}) + (1 - \beta)b_{t-1} \quad (12)$$

Where:

b_t – smoothed trend at time t

β – trend smoothing parameter ($0 \leq \beta \leq 1$)

$l_t - l_{t-1}$ – change in the level between the current and previous time step

3. Forecast:

$$\hat{y}_{t+k} = l_t + kb_t \quad (13)$$

Where:

$\hat{y}_{t+k}$ – Forecast for k – steps ahead

k – forecast horizon

l_t – smoothed level at the most recent time step

b_t – smoothed trend at the most recent time step

To calculate the total return of an asset over a certain period of time based on its daily logarithmic returns, one of two formulas can be potentially used [68]:

$$\text{Cumulative Growth} = \exp \left(\sum_{k=t_0+1}^t \ln \left(\frac{P_k}{P_{k-1}} \right) \right) \quad (14)$$

Where:

t_0 is the starting day – the day before the first return calculation

t is the random target day until the overall growth will be calculated

P_k is the closing price of the asset on the day k

P_{k-1} - closing price of the asset on the previous day

Or the following formula:

$$\text{Cumulative Growth} = \prod_{k=t_0+1}^t \left(e^{\ln \left(\frac{P_k}{P_{k-1}} \right)} \right) \quad (15)$$

Where:

t_0 is the starting day – the day before the first return calculation

t is the random target day until the overall growth will be calculated

P_k is the closing price of the asset on the day k

P_{k-1} - closing price of the asset on the previous day

For volatile assets formula (14) is preferred as it provides a more stable additive method for compounding returns over multiple periods of time.

As well as mentioned above methods, graph observation method will be used as well. The box plot and other graphs will be observed to detect outliers to compare them with the selected events and to find out how stable the crypto market is in general.

2.3 Used Programs

Two programs were used to analyze the data and to forecast the future exchange rates.

Microsoft Excel 2016 is a spreadsheet program developed by Microsoft corporation that is designed to create, manage and to analyze data. The application allows users to organize information in rows and columns, to do calculations with formulas, to visualize data using charts and graphs [61].

IBM SPSS Statistics version 30.0.0.0 is statistical software designed by IBM corporation for data analysis, hypothesis testing, predictive analytics. The program supports trend analysis, forecasting, ad hoc analysis as well as data visualization [62].

A good replacement for the second one could be Gretl – statistical open-source software that is designed for purposes similar to IBM SPSS [63]. As well as Microsoft Excel could be replaced by OpenOffice Calc due to the fact Microsoft Excel and IBM SPSS Statistics are paid [64].

To test formulas 14 and 15 (they should display the same result), a program was created using Python 3.8. The program's results are shown in the figure 11, using data from Table 8. Since the table shows Bitcoin daily returns as percentages, they were divided by 100 for the analysis. The program's code is shown below:

```
import math

def cumulative_growth_sum(log_values):
    total_log_sum = sum(log_values)
    cumulative_growth = math.exp(total_log_sum)
    return (cumulative_growth - 1) * 100

def cumulative_growth_product(log_values):
    product = 1
    for log_val in log_values:
        product *= math.exp(log_val)
    return (product - 1) * 100

def select_interval(log_values, event_index, lower_bound,
upper_bound):
    start_index = max(0, event_index + lower_bound + 1)
    end_index = min(len(log_values), event_index +
upper_bound + 1)
    return log_values[start_index:end_index]

if __name__ == "__main__":
    log_values = list(map(float, input("Enter a list of ln
values separated by spaces: ").split()))
    print(f"Input data:")
    for i, value in enumerate(log_values):
        print(f"Index {i}, Value {value}")

    event_index = int(input(f"Select the event index (0 -
{len(log_values) - 1}): "))
    lower_bound = int(input("Enter the lower bound: "))
    upper_bound = int(input("Enter the upper bound: "))
    selected_values = select_interval(log_values,
event_index, lower_bound, upper_bound)

    if not selected_values:
        print("The selected interval is empty.")
    else:
```

```

        print(f"Selected interval: {selected_values}")

        growth_sum = cumulative_growth_sum(selected_values)
        growth_product = cumulative_growth_product(selected_values)

        print(f"Cumulative growth by sum: {growth_sum: .2f}%")
        print(f"Cumulative growth by product: {growth_product:
.2f}%")
Selected interval: [0.0065, 0.0316, -0.001, 0.0061, -0.0216, -0.0092, -0.0238, 0.0115, -0.0614]
Cumulative growth by sum: -5.95%
Cumulative growth by product: -5.95%

** Process exited - Return Code: 0 **
Press Enter to exit terminal

```

Figure 11. Comparison of Program Results for Formulas 14 and 15 Using Bitcoin Daily Returns Data

According to the figure 11 both formulas display the same results that is also the same Microsoft Excel provided in the table 21 for Bitcoin ACTUAL Cumulative Returns Around the Event Window (%) [-3; 6] Days.

Another program was developed using Python 3.8 to test the results of the correlation analysis. The program forms up a correlation matrix based on 2704 observations used for the analysis. Program's results displayed in the figure 12 and the code of the program is listed below:

```

import statistics

def correlation(x, y):
    mean_x = statistics.mean(x)
    mean_y = statistics.mean(y)
    stdev_x = statistics.stdev(x)
    stdev_y = statistics.stdev(y)

    numerator = sum((x[i] - mean_x) * (y[i] - mean_y) for
i in range(len(x)))
    denominator = (sum((x[i] - mean_x)**2 for i in
range(len(x))) * sum((y[i] - mean_y)**2 for i in
range(len(y))))**0.5
    return numerator / denominator if denominator != 0
else 0

n = int(input("Enter the number of lists: "))
data = []

for i in range(n):

```

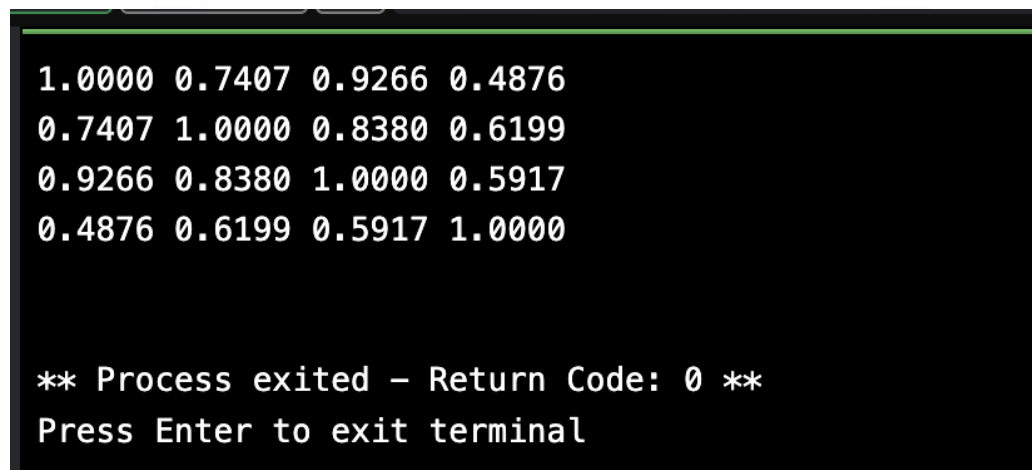
```

        values = list(map(float, input(f"Enter the values for
list {i + 1}, separated by spaces: ").split()))
        data.append(values)

correlation_matrix = []
for i in range(n):
    row = []
    for j in range(n):
        row.append(correlation(data[i], data[j]))
    correlation_matrix.append(row)

print("\nCorrelation matrix:")
for row in correlation_matrix:
    print(" ".join(f"{val:.4f}" for val in row))

```



```

1.0000 0.7407 0.9266 0.4876
0.7407 1.0000 0.8380 0.6199
0.9266 0.8380 1.0000 0.5917
0.4876 0.6199 0.5917 1.0000

** Process exited - Return Code: 0 **
Press Enter to exit terminal

```

Figure 12. Correlation Matrix of 2704 Observations Calculated by Program Coded Using Python 3.8

The results displayed in the figure 12 are similar with the ones provided in the table 6 calculated using Microsoft Excel.

THIRD PART

ANALYSIS AND FINDINGS

3.1 Dataset Analysis

Data standardization process requires mean and standard deviation metrics. Therefore, at first descriptive statistics is required. It displays more indicators than only the required ones for standardization such as mean and standard deviation but also displays following metrics:

- Standard error - an estimate of the standard deviation of the sample mean that indicates variability
- Median - the middle value of the dataset when sorted
- Mode – the most displayed value in the dataset
- Sample variance – displays data dispersion and is a square of the standard deviation
- Kurtosis – describes how heavy or light the tails are compared to a normal distribution
- Skewness – shows the asymmetry of the dataset distribution
- Range – displays the difference between the maximum and minimum values
- Minimum – the smallest value in the dataset
- Maximum – the biggest value in the dataset
- Sum – displays the sum of all the values in the dataset
- Count – the amount of observation used

Descriptive statistics for every used indicator are presented in the Table 4.

Table 4. Descriptive Statistics of Used Cryptocurrencies

BITCOIN		DOGECOIN	
Mean	24820.24419	Mean	0.066283614
Standard Error	381.857402	Standard Error	0.001661414
Median	19014.7	Median	0.050525
Mode	3870.3	Mode	0.002476
Standard Deviation	19856.5849	Standard Deviation	0.086393531
Sample Variance	394283964	Sample Variance	0.007463842

Kurtosis	-0.674562939	Kurtosis	6.159251722
Skewness	0.769848247	Skewness	2.044635769
Range	71152.2	Range	0.686106
Minimum	1914.1	Minimum	0.000774
Maximum	73066.3	Maximum	0.68688
Sum	67113940.3	Sum	179.230892
Count	2704	Count	2704
ETHEREUM		RIPPLE(XRP)	
Mean	1375.279626	Mean	0.504643306
Standard Error	23.0686944	Standard Error	0.005845895
Median	1202.305	Median	0.45365
Mode	218	Mode	0.2457
Standard Deviation	1199.572109	Standard Deviation	0.303986521
Sample Variance	1438973.244	Sample Variance	0.092407805
Kurtosis	-0.630258477	Kurtosis	8.300627055
Skewness	0.698121052	Skewness	2.215174165
Range	4724.57	Range	2.644
Minimum	83.81	Minimum	0.136
Maximum	4808.38	Maximum	2.78
Sum	3718756.11	Sum	1364.5555
Count	2704	Count	2704

After the descriptive statistics is calculated it is necessary to standardize the metrics as it was mentioned in the methodology. The example of standardized data is presented in the Table 5.

Table 5. Example of Standardized Data

DATE	BITCOIN	DOGECOIN	ETHEREUM	RIPPLE(XRP)
21.10.2024	2.1429	0.8954	1.0765	0.1324
22.10.2024	2.1457	0.8491	1.0391	0.0959
23.10.2024	2.1073	0.8539	0.9594	0.0696
24.10.2024	2.1842	0.8750	0.9675	0.0900
25.10.2024	2.1090	0.7579	0.8886	-0.0077
26.10.2024	2.1286	0.8234	0.9230	0.0288
27.10.2024	2.1519	0.8647	0.9271	0.0318

After standardization correlation analysis will be used to determine the relationships between selected variables and as a result a correlation matrix will be

computed that shows pairwise correlation coefficients between them. The result of correlation analysis is displayed in the Table 6.

Table 6. The Correlation Matrix for The Selected Cryptocurrencies

	BITCOIN	DOGECOIN	ETHEREUM	RIPPLE(XRP)
BITCOIN	1	0.74	0.93	0.49
DOGECOIN	0.74	1	0.84	0.62
ETHEREUM	0.93	0.84	1	0.59
RIPPLE(XRP)	0.49	0.62	0.59	1

Based on the results displayed in the Table 6 it is fair to conclude:

1. There is a strong correlation ($|r| > 0.7$) between Bitcoin and Dogecoin (0.74) that indicates positive linear relationship. The coefficient is positive meaning that as Bitcoin price increases Dogecoin price also tends to increase. Consequently, if Bitcoin price decreases, Dogecoin will likely decrease as well. The value (0.74) is not a perfect correlation that would be 1.0, but it still displays strong relationships, however there is still a room for other factors affecting Dogecoin that are not explained by Bitcoin price changes.
2. There is a very strong correlation ($|r| > 0.7$) between Bitcoin and Ethereum (0.93) that suggests a very strong positive linear relationship. The coefficient is close to the perfect value which is 1.0 and is positive meaning that as Bitcoin price increases Ethereum price also tends to increase in a predictable way. Similarly, if Bitcoin price decreases Ethereum price is likely to decrease as well. At the same time there still could be minor deviation or factors influencing Ethereum that are not only captured by Bitcoin price changes.
3. There is a moderate correlation ($0.4 \leq |r| \leq 0.7$) between Bitcoin and Ripple (XRP) (0.49) that displays neither weak nor strong relationship. The coefficient is positive so as Bitcoin increases Ripple tends to increase and when Bitcoin decreases Ripple generally decreases as well. However, the relationship is not strong enough the price of Ripple (XRP) based solely on Bitcoin price trends with high accuracy, so it means even if they are somewhat related there is still significant variability and other factors might influence the price of Ripple (XRP)

4. There is a strong correlation ($|r| > 0.7$) between Dogecoin and Ethereum (0.84) that indicates a strong positive linear relationship. The coefficient is positive and is close to the perfect correlation value (1.0) therefore it is fair to conclude both Dogecoin and Ethereum tend to move together in a predictable way. So, if Dogecoin price increases Ethereum price tends to increase, and if Dogecoin price decreases Ethereum price is likely to decrease as well. Despite the fact the relationship is strong enough there still could be some variability or other factors affecting Ethereum.
5. There is a moderate correlation ($0.4 \leq |r| \leq 0.7$) between Dogecoin and Ripple (XRP) (0.62) that is considered a moderate-to-strong relationship. It means both variables tend to increase together, however still with some degree of variability in how closely they follow each other. The relationship is not perfectly strong therefore other factors might be affecting Ripple (XRP) prices beyond just the price of Dogecoin. It is also important to notice that the correlation between Dogecoin and Ripple (XRP) that is 0.62 is a bit higher than the correlation between Bitcoin and Ripple (XRP) 0.49.
6. There is a moderate correlation ($0.4 \leq |r| \leq 0.7$) between Ethereum and Ripple (XRP) (0.59) that indicates a moderate positive relationship. It suggests that Ethereum and Ripple (XRP) are somewhat related, but the relationship is not extremely strong. The coefficient is positive so it means if Ethereum price increases Ripple (XRP) price tends to increase and when Ethereum price decreases Ripple (XRP) price will generally decrease as well. However, due to the fact the relationship is not perfectly consistent and despite the tendency of moving together there is still a fair amount of variability, and the relationship is not perfectly predictable as well as other factors could be influencing Ripple (XRP) besides Ethereum. It is also interesting to notice that once again the correlation between Ethereum and Ripple (XRP) (0.59) is a bit higher than the correlation between the most valuable cryptocurrency (Bitcoin) and Ripple (XRP) (0.49).

In conclusion it is essential to remember that even if there is a very strong correlation between two variables it doesn't mean that changes in one will

necessarily cause changes in the other as it rather displays a strong tendency to change together in time.

Based on the correlation coefficients there also could be some multicollinearity, particularly between: Bitcoin and Ethereum (0.93) and Dogecoin and Ethereum (0.84), however due to the fact there is no clear resulting factor regression analysis will not be performed.

A graph of standardized distribution displayed on the Figure 13 was plotted using standardized data.

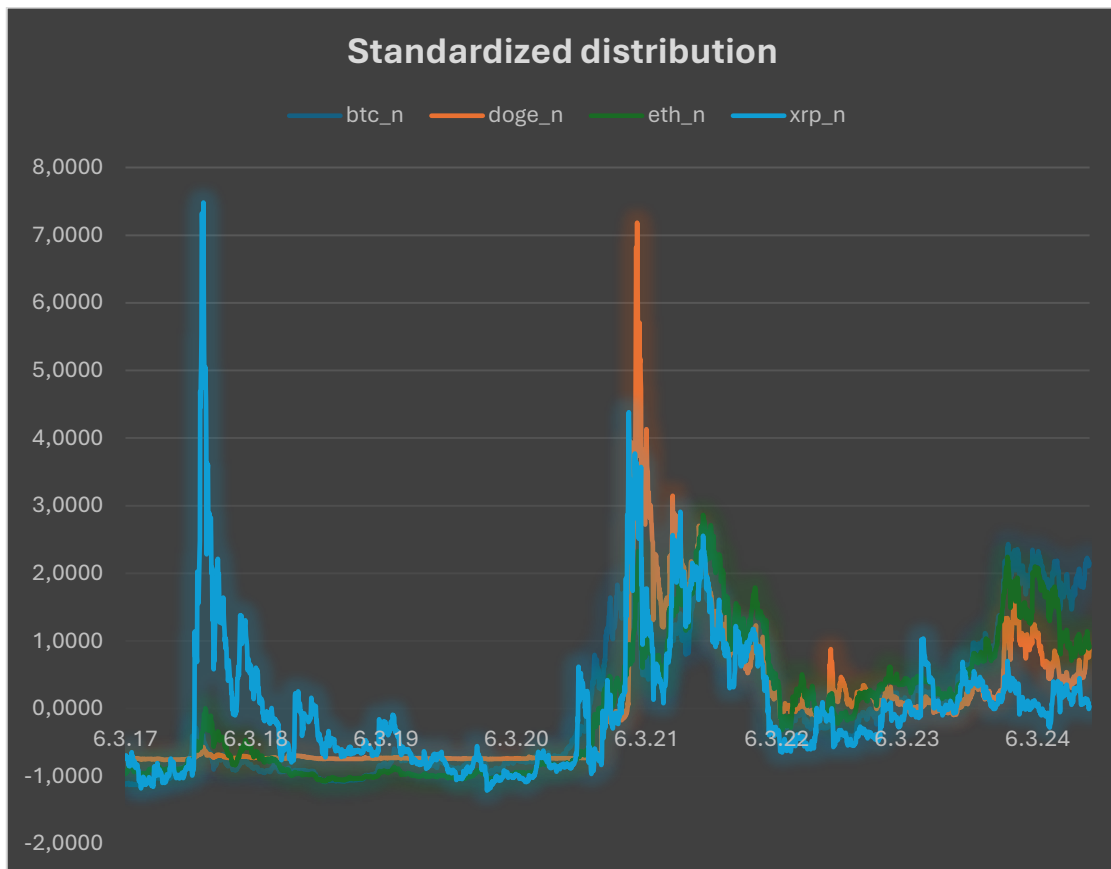


Figure 13. Standardized Distribution of Four Selected Cryptocurrencies from 03 June 2017 to 27 October 2024

The graph displays the price dynamics of 4 selected cryptocurrencies (Bitcoin (btc_n), Dogecoin (doge_n), Ethereum (eth_n), Ripple (xrp_n)). By observing the graph is fair to conclude there is no clear seasonality factor, due to the fact that predictable patterns don't occur at regular intervals. The graph displays rather stable market behavior with two massive outliers on it.

The first massive outlier touches mostly Ripple (XRP) with the price increase from \$0.25 USD in early December 2017 to over \$3 USD by the first days of January 2018 – a near 1200% increase in just a few weeks. The prices of other currencies also increased; however, Ripple’s (XRP) increase was notably faster compared to many other cryptocurrencies in the observed period of time (early December 2017 – the first days of January 2018). This increase in Ripple’s (XRP) price was driven by speculation, traders rushed into the market expecting further growth along with news of Ripple’s developing partnerships with financial institutions.

The second outlier in the middle of the graph happened during the pandemic of COVID-19 when all the cryptocurrencies were recovering and surging after an initial drop when the pandemic was announced.

To confirm that the crypto market shows rather stable behavior it is fair to compare it with, for example, Intel corporation 44 years price history graph (prices in USD) displayed on the Figure 14.



Figure 14. Intel Corporation 44-Year Price History (Prices in USD)

Source: [65].

And with Bitcoin price history graph (prices in USD) displayed on the Figure 15.



Figure 15. Bitcoin Price History (Prices in USD)

Source: [66].

A boxplot can also display the stability of an asset. Definitely, it is not the primary tool to measure stability, however it can still visualize the dispersion and central tendency of the asset's price data that can indirectly display how stable or volatile the asset is over a selected period of time. Every boxplot has its key elements such as:

- Median (the line in the middle) – represents the median (50th percentile) of the data, displaying the central tendency of the asset's price
- Interquartile range – the box itself represents the middle 50% of the data, from the 25th percentile to the 75th, when the range is narrow it suggests less volatility and indicating more stability
- Whiskers – the lines extending from the box display the range of values outside the interquartile range up to a certain limit, the longer they are the higher volatility is and consequently less stability.
- Outliers – data points outside the whiskers are displayed as individual points or small stars – a huge number of points demonstrates periods of instability or high volatility.

Figure 16 displays boxplot of Bitcoin closing prices. It is easy to notice that there are no any outliers. It indicates that while there's a variability, the price stays within a reasonable range without extreme deviations. However, the box itself is moderately thick indicating significant variability in typical values. There is a long

upper whisker as well showing a broader range of data outside the interquartile range; however, the length is not extreme.

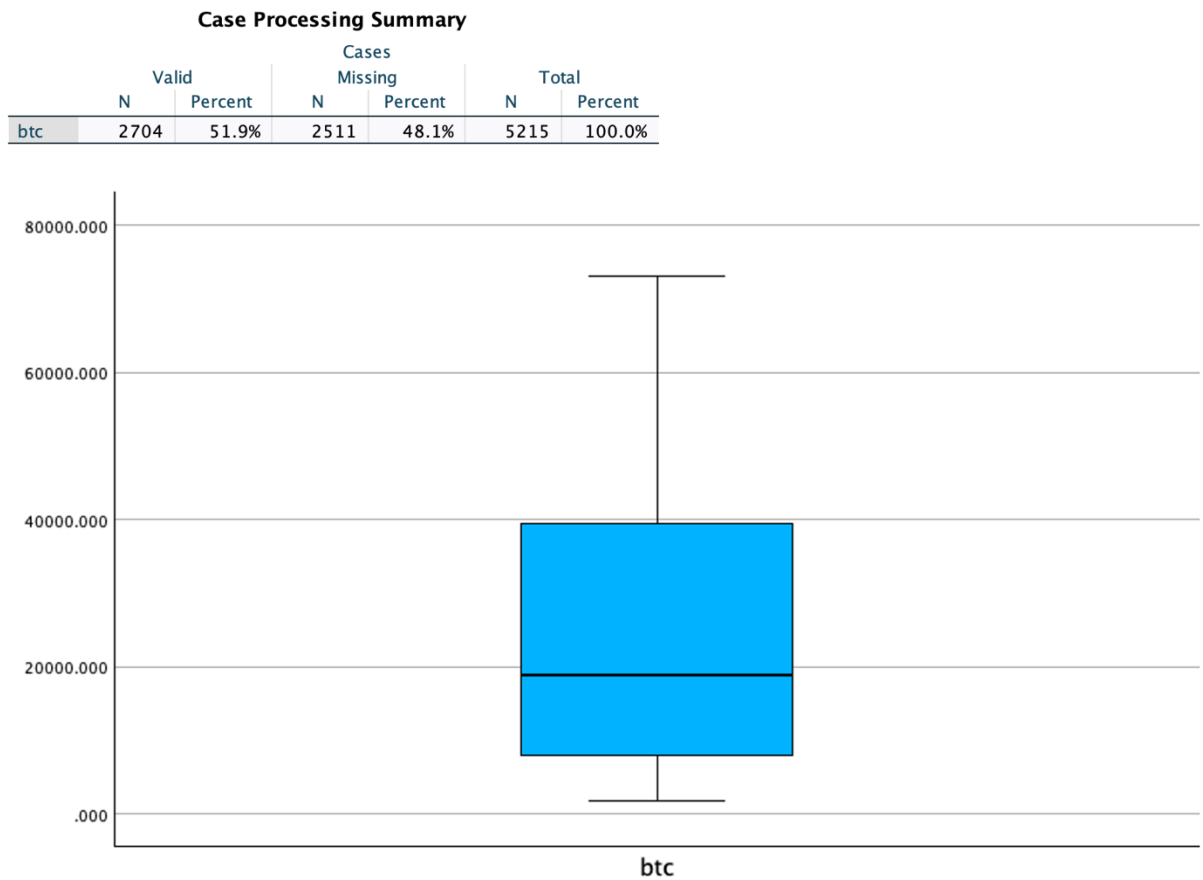


Figure 16. Boxplot of Bitcoin Closing Prices from 03 June 2017 to 27 October 2024

Consequently, the boxplot of Bitcoin closing prices displays moderate volatility without any extreme deviations as there are no any outliers as well as no drastic price swings.

The next figure (Figure 17) shows boxplot of Ethereum closing prices. It looks almost the same with the Bitcoin's graph (Figure 16). It is also moderately thick indicating significant variability in typical values with a long upper whisker (the length is moderate). As well as the Bitcoin's graph it doesn't have any outliers meaning that the price stays within a reasonable range without extreme deviations.

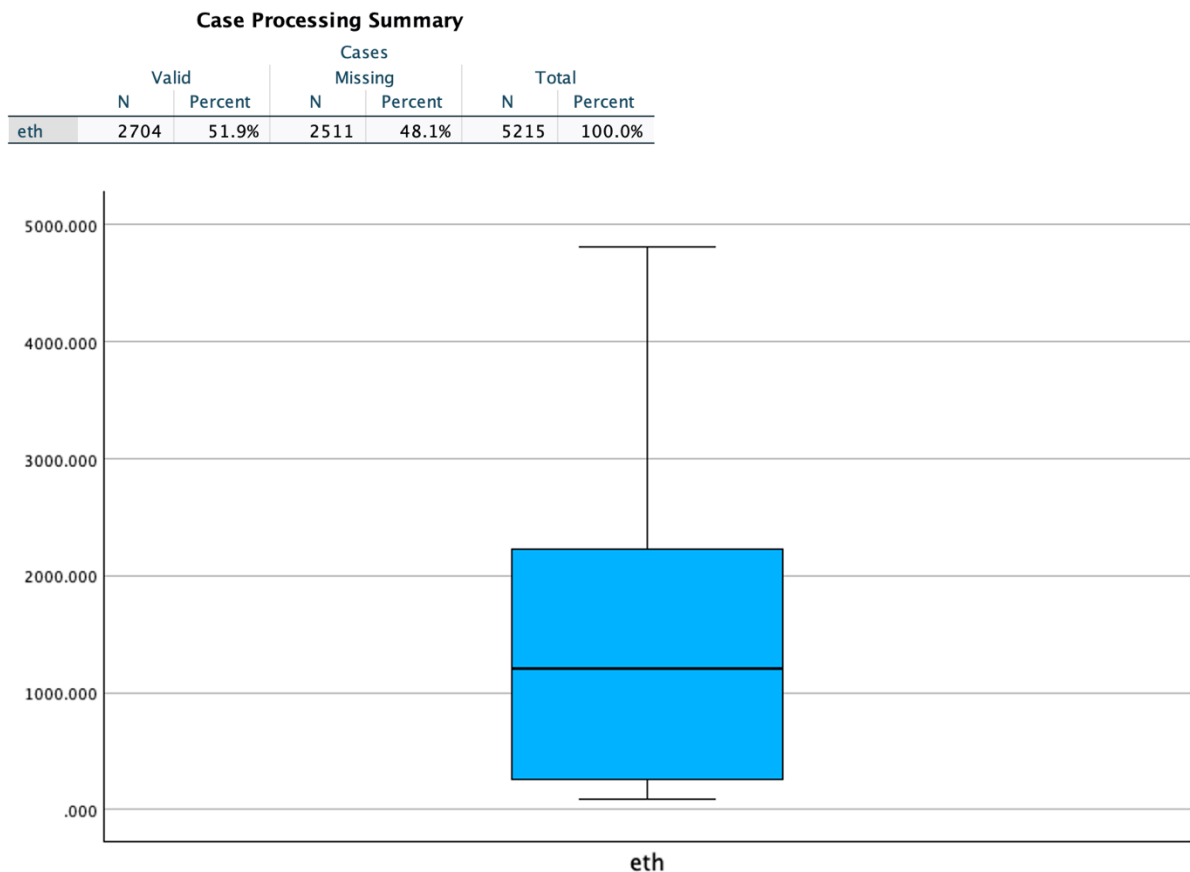


Figure 17. Boxplot of Ethereum Closing Prices from 03 June 2017 to 27 October 2024

Similarly, with the Figure 16 it is fair to conclude that boxplot of Ethereum closing prices indicates moderate volatility without any extreme deviations as there are no outliers and no drastic price changes as well.

The next figure (Figure 18) displays the boxplot of Dogecoin closing prices. Obviously, it looks far more unstable due to the amount of outliers on it. The outliers indicate price extremes and highlight the days of unusual behavior. The upper whisker is long and combined with the outliers suggests noticeable variability. As well as the interquartile range that is moderately wide that indicates variability in the 50% of the data. It is also important to notice its asymmetric distribution due to outlier appearing only on the upper side of the graph meaning that the price has experienced more frequent positive spikes or so-called upward volatility.

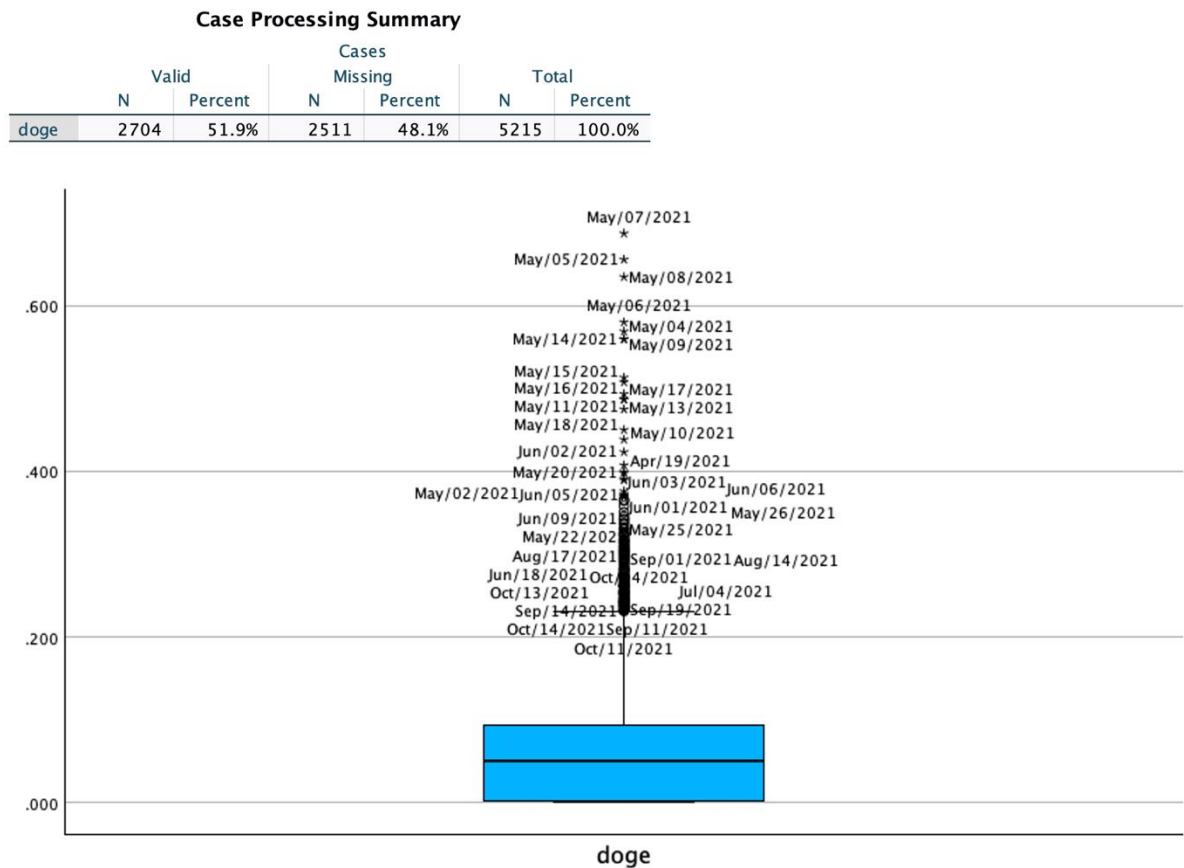


Figure 18. Boxplot of Dogecoin Closing Prices from 03 June 2017 to 27 October 2024

Consequently, the asset (Dogecoin) exhibits much higher volatility compared to the previous examples such were: Bitcoin and Ethereum and is considered as an extremely high volatile asset. The number of outliers is rather big with a tendency toward asymmetric spikes.

Figure 19 shows the boxplot of Ripple (XRP) closing prices. As well as Dogecoin the boxplot of Ripple indicates a huge amount of outliers with an asymmetric behavior suggesting strong positive price spikes as the outliers are located above the upper whisker. The whiskers are long, and it shows that the data points go beyond the interquartile range while staying within the non-outlier range.

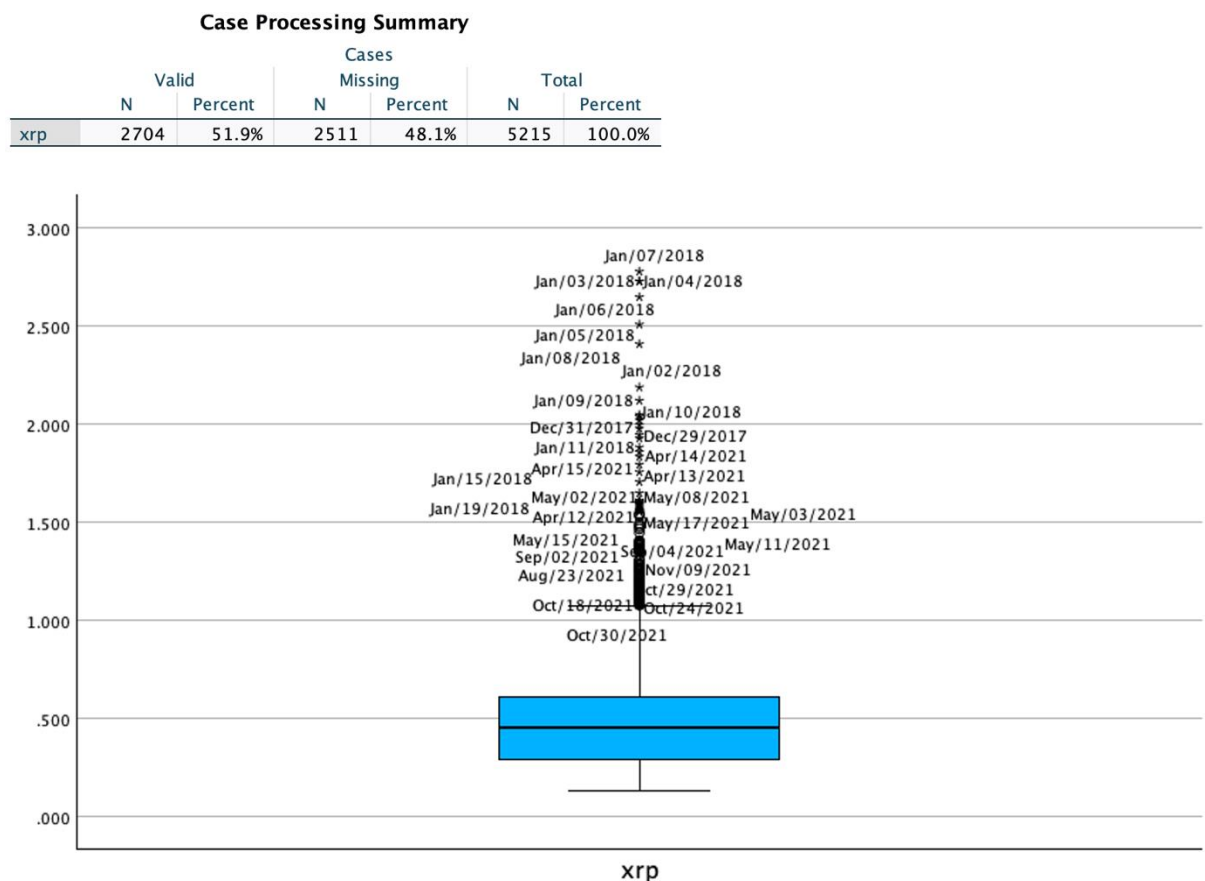


Figure 19. Boxplot of Ripple (XRP) Closing Prices from 03 June 2017 to 27 October 2024

The boxplot indicates an extremely volatile asset with an asymmetry toward the upper end and with plenty of outliers that represent unpredictable and substantial price changes.

In conclusion Table 7 underlines the difference between graphs.

Table 7. Comparison of Closing Price Distributions for Bitcoin, Ethereum, Ripple, and Dogecoin

Feature	BITCOIN	ETHEREUM	DOGECOIN	RIPPLE (XRP)
Interquartile Range	Moderate Thickness	Moderate Thickness	Moderate Thickness	Moderate Thickness
Whiskers	Moderate asymmetric (upper is longer)	Moderate asymmetric (upper is longer)	Long asymmetric (upper is longer)	Moderate asymmetric (upper is longer)
Outliers	None	None	Many, all of them on the upper side	Many, all of them on the upper side
Volatility Level	Moderate Level	Moderate Level	Extremely high level	Extremely high level

As a result of graphical analysis, it is fair to conclude that the selected cryptocurrencies (Bitcoin, Ethereum, Dogecoin, Ripple (XRP)) display a stable market behavior without having constant massive outliers. At the same time analysis using boxplots indicates that the two most valuable cryptocurrencies (Bitcoin, Ethereum) are moderate volatility level assets while two less valuable ones (Dogecoin, Ripple (XRP)) are considered extremely high volatility level assets. The lack of outliers or otherwise it is abundance on boxplots doesn't automatically mean that announcements or other events don't have an impact on the assets or otherwise all the outliers are the result of them. Analysis using boxplots only displays the level of volatility and the lack of outliers or its presence don't necessarily mean the announcements have no significant influence on every selected crypto asset.

The results of usage Holt's Linear Trend Method is displayed on the figure 20 that displays Model Fit and Model Statistics and, on the figure 21, four graphics with the actual forecasts for each selected cryptocurrency is shown. The following results will be used to compare actual daily returns and cryptocurrency prices considering the announcement effect with the forecasted values.

Model Fit											
Fit Statistic	Mean	SE	Minimum	Maximum	5	10	25	Percentile			
					50	75	90	95			
Stationary R-squared	.530	.023	.504	.558	.504	.504	.509	.530	.552	.558	.558
R-squared	.989	.009	.979	.997	.979	.979	.980	.991	.997	.997	.997
RMSE	279.275	509.069	.010	1040.984	.010	.010	.019	38.053	799.754	1040.984	1040.984
MAPE	3.438	.756	2.540	4.377	2.540	2.540	2.731	3.417	4.165	4.377	4.377
MaxAPE	74.422	7.694	64.815	81.964	64.815	64.815	66.569	75.455	81.243	81.964	81.964
MAE	158.227	289.551	.003	591.571	.003	.003	.007	20.667	454.007	591.571	591.571
MaxAE	2112.708	3627.203	.189	7513.066	.189	.189	.309	468.789	5869.026	7513.066	7513.066
Normalized BIC	1.803	11.219	-9.135	13.902	-9.135	-9.135	-8.407	1.222	12.594	13.902	13.902

Model Statistics												
Model	Number of Predictors	Model Fit statistics						Normalized BIC	Ljung-Box Q(18)			Number of Outliers
		R-squared	RMSE	MAPE	MAE	MaxAPE	MaxAE		Statistics	DF	Sig.	
btc-Model_1	0	.997	1040.984	2.540	591.571	64.815	7513.066	13.902	34.697	16	<.004	<.001
doge-Model_2	0	.986	.010	4.377	.003	79.081	.189	-9.135	398.675	16	<.001	<.001
eth-Model_3	0	.996	76.062	3.304	41.314	81.964	936.908	8.669	65.317	16	<.001	<.001
xrp-Model_4	0	.979	.044	3.530	.020	71.830	.670	-6.224	139.597	16	<.001	<.001

Figure 20. The Results of Holt's Linear Trend Method: Model Fit and Model Statistics

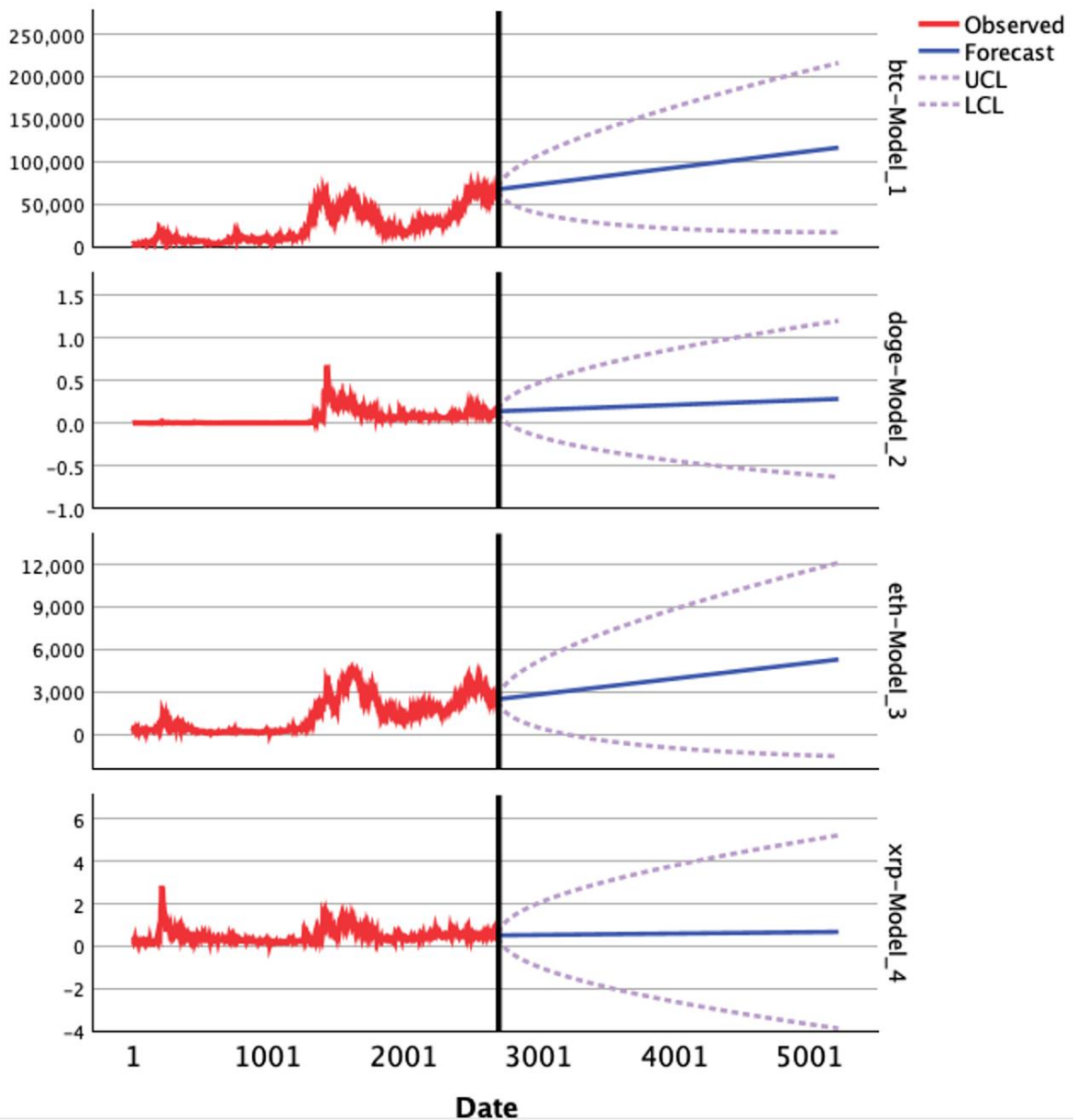


Figure 21. Actual Forecasts for Selected Cryptocurrencies from 03.06.2017 to 27.10.2024 and from 27.10.2024 to 12.09.2031

Every selected cryptocurrency shows a positive growing trend. The horizon of the forecast is long-term, and it covers more than 5000 days. From 03.06.2017 to 27.10.2024 the used data is known, so the method forecasts the prices based on the natural market behavior considering announcements after they occur. The second part of the forecast from 27.10.2024 to 12.09.2031 is based on the previous dataset (03.06.2017 - 27.10.2024). Obviously, it might not be precise enough due to its long duration, however it clearly displays the trends. For example, the model says that

Bitcoin will be \$100000 USD worth on 20.05.2029, however it happened much earlier 05.12.2024 [67]. Despite this, it is necessary to see the trends that indicate all the selected cryptocurrencies (Bitcoin, Ethereum, Dogecoin and Ripple (XRP)) have the tendency to grow even without announcements or other events, as well as, it was mentioned above some of them have a clear upward volatility.

3.2 The Impact of Announcements

The following Tables 8-20 display the market behavior three days before the selected event (Day -3, Day -2, Day -1), the day the event occurs (Day 0) and the consequences of it within a period of six days (Day 1, Day 2, Day 3, Day 4, Day 5, Day 6). A [-3; +6] days window may appear unconventional when compared to traditional event studies, but it is likely selected to more effectively capture the unique characteristics of the cryptocurrency market, where delayed reactions, rumors, and speculative behavior can play a significant role. Robustness test was also performed and more common event windows such as [-4; 4] and [-3; 3] were observed as well, the results are presented in the table 20. Each table displays all price fluctuations (in USD) (actual and forecasted), as well as, actual and forecasted daily returns (in %) of each selected cryptocurrency (Bitcoin, Ethereum, Dogecoin, Ripple (XRP)) before, during and after the announcement occurred, the impact of the chosen announcements. Daily returns start from the second day before the announcement due to the division in the used formula (closing price of the asset on the selected day by closing price of the asset on the previous day), the previous day to Day -3 was not used therefore daily returns for the first days were not calculated and the cell is blank.

Table 8. Market Behavior and Daily Returns for Cryptocurrencies Following Donald Trump's Pledge to Make the U.S. 'Crypto Capital of the Planet'

Donald Trump's Pledge to Make the U.S. 'Crypto Capital of the Planet'							
EVENT	27.07.2024 Donald Trump pledged to make the U.S. the "crypto capital of the planet" if he wins the 2024 election, proposing to end the "war on crypto," establish a federal Bitcoin reserve, and promote Bitcoin mining and transactions. Type: Public speech of an opinion leader						
IMPACT	Positive						
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	65370.5	Day - 3	3335.3	Day - 3	0.127940	Day - 3	0.6183
Day - 2	65799.3	Day - 2	3175.5	Day - 2	0.125274	Day - 2	0.5995

Day - 1	67908.6	Day - 1	3275.1	Day - 1	0.134203	Day - 1	0.6034
Day 0	67843.1	Day 0	3247.1	Day 0	0.131284	Day 0	0.5957
Day 1	68256.3	Day 1	3270.3	Day 1	0.130048	Day 1	0.6014
Day 2	66798.7	Day 2	3318.2	Day 2	0.128439	Day 2	0.6024
Day 3	66184.9	Day 3	3278.9	Day 3	0.125486	Day 3	0.6274
Day 4	64626.0	Day 4	3231.8	Day 4	0.121920	Day 4	0.6231
Day 5	65372.9	Day 5	3204.9	Day 5	0.119135	Day 5	0.5965
Day 6	61478.7	Day 6	2990.3	Day 6	0.111578	Day 6	0.5608
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	65999.8	Day - 3	3480.8	Day - 3	0.131130	Day - 3	0.5976
Day - 2	65406.2	Day - 2	3349.1	Day - 2	0.128317	Day - 2	0.6183
Day - 1	65808.7	Day - 1	3191.8	Day - 1	0.125636	Day - 1	0.5996
Day 0	67874.1	Day 0	3269.0	Day 0	0.133403	Day 0	0.6035
Day 1	67863.4	Day 1	3250.1	Day 1	0.131554	Day 1	0.5958
Day 2	68265.7	Day 2	3269.7	Day 2	0.130256	Day 2	0.6015
Day 3	66855.9	Day 3	3315.1	Day 3	0.128679	Day 3	0.6025
Day 4	66221.7	Day 4	3283.2	Day 4	0.125863	Day 4	0.6274
Day 5	64686.6	Day 5	3237.4	Day 5	0.122372	Day 5	0.6232
Day 6	65374.7	Day 6	3208.9	Day 6	0.119517	Day 6	0.5966
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	0.65	Day - 2	-4.91	Day - 2	-2.11	Day - 2	-3.09
Day - 1	3.16	Day - 1	3.09	Day - 1	6.89	Day - 1	0.65
Day 0	-0.10	Day 0	-0.86	Day 0	-2.20	Day 0	-1.28
Day 1	0.61	Day 1	0.71	Day 1	-0.95	Day 1	0.95
Day 2	-2.16	Day 2	1.45	Day 2	-1.24	Day 2	0.17
Day 3	-0.92	Day 3	-1.19	Day 3	-2.33	Day 3	4.07
Day 4	-2.38	Day 4	-1.45	Day 4	-2.88	Day 4	-0.69
Day 5	1.15	Day 5	-0.84	Day 5	-2.31	Day 5	-4.36
Day 6	-6.14	Day 6	-6.93	Day 6	-6.55	Day 6	-6.17
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	

Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-0.90	Day - 2	-3.86	Day - 2	-2.17	Day - 2	3.41
Day - 1	0.61	Day - 1	-4.81	Day - 1	-2.11	Day - 1	-3.07
Day 0	3.09	Day 0	2.39	Day 0	6.00	Day 0	0.65
Day 1	-0.02	Day 1	-0.58	Day 1	-1.40	Day 1	-1.28
Day 2	0.59	Day 2	0.60	Day 2	-0.99	Day 2	0.95
Day 3	-2.09	Day 3	1.38	Day 3	-1.22	Day 3	0.17
Day 4	-0.95	Day 4	-0.97	Day 4	-2.21	Day 4	4.05
Day 5	-2.35	Day 5	-1.40	Day 5	-2.81	Day 5	-0.67
Day 6	1.06	Day 6	-0.88	Day 6	-2.36	Day 6	-4.36

Table 8 displays one of the recent events happened on 27.07.2024 when the US presidential candidate (a former president) promised to make the U.S. the "crypto capital of the planet", to establish a federal Bitcoin reserve, to promote Bitcoin mining and transactions giving a public speech in Nashville, USA. During the conference the Bitcoin's price peaked \$69,000 USD, however the closing price was lower than the day earlier (\$67,908.6 USD) displaying the stability of the currency [69]. Other three currencies reacted similarly. The event is considered positive, however the positive impact of it was only visible right during the Trump's speech and the closing price of Bitcoin doesn't display that. The conference was named "Bitcoin 2024" and held from July 25 to July 27, 2024 [69]. The following combination sounds more than just positive – a conference that highlights the future of Bitcoin and a potential president of the US promises incredibly good things for the currency, however the market reacts on it for less than a trading day. The real potential impact of the following speech could be observed few months later on 05.12.2024 helping Bitcoin to reach an outstanding value of \$100,000 USD [67].

Table 9. Market Behavior and Daily Returns for Cryptocurrencies Following U.S. Judge's Ruling on XRP (13.07.2023, Days -3 to 6)

EVENT	13.07.2023 A U.S. judge ruled XRP was not a security on exchanges, causing XRP to surge and boosting positive sentiment in the crypto market. Type: Regulatory action						
IMPACT	Positive						
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	30415.3	Day - 3	1880.4	Day - 3	0.065233	Day - 3	0.4780
Day - 2	30623.3	Day - 2	1878.3	Day - 2	0.065269	Day - 2	0.4753

Day - 1	30387.3	Day - 1	1871.9	Day - 1	0.065031	Day - 1	0.4711
Day 0	31466.1	Day 0	2004.8	Day 0	0.070395	Day 0	0.8150
Day 1	30317.4	Day 1	1938.1	Day 1	0.068517	Day 1	0.7182
Day 2	30291.4	Day 2	1931.4	Day 2	0.071951	Day 2	0.7145
Day 3	30235.5	Day 3	1922.5	Day 3	0.069530	Day 3	0.7470
Day 4	30139.7	Day 4	1911.2	Day 4	0.069836	Day 4	0.7375
Day 5	29866.8	Day 5	1897.6	Day 5	0.068665	Day 5	0.7790
Day 6	29909.7	Day 6	1888.7	Day 6	0.070033	Day 6	0.8198
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	30190.1	Day - 3	1864.4	Day - 3	0.065461	Day - 3	0.4682
Day - 2	30429.0	Day - 2	1880.1	Day - 2	0.065313	Day - 2	0.4781
Day - 1	30637.8	Day - 1	1879.6	Day - 1	0.065331	Day - 1	0.4754
Day 0	30413.2	Day 0	1873.6	Day 0	0.065119	Day 0	0.4712
Day 1	31458.5	Day 1	1994.4	Day 1	0.069925	Day 1	0.8147
Day 2	30366.2	Day 2	1944.1	Day 2	0.068715	Day 2	0.7184
Day 3	30312.8	Day 3	1933.6	Day 3	0.071685	Day 3	0.7146
Day 4	30257.0	Day 4	1924.5	Day 4	0.069803	Day 4	0.7470
Day 5	30162.2	Day 5	1913.5	Day 5	0.069890	Day 5	0.7376
Day 6	29893.9	Day 6	1900.1	Day 6	0.068845	Day 6	0.7790
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	0.68	Day - 2	-0.11	Day - 2	0.06	Day - 2	-0.57
Day - 1	-0.77	Day - 1	-0.35	Day - 1	-0.37	Day - 1	-0.89
Day 0	3.49	Day 0	6.86	Day 0	7.93	Day 0	54.81
Day 1	-3.72	Day 1	-3.38	Day 1	-2.70	Day 1	-12.64
Day 2	-0.09	Day 2	-0.34	Day 2	4.89	Day 2	-0.52
Day 3	-0.18	Day 3	-0.47	Day 3	-3.42	Day 3	4.45
Day 4	-0.32	Day 4	-0.58	Day 4	0.44	Day 4	-1.28
Day 5	-0.91	Day 5	-0.72	Day 5	-1.69	Day 5	5.47
Day 6	0.14	Day 6	-0.47	Day 6	1.97	Day 6	5.10
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	

Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	0.79	Day - 2	0.84	Day - 2	-0.23	Day - 2	2.09
Day - 1	0.68	Day - 1	-0.03	Day - 1	0.03	Day - 1	-0.57
Day 0	-0.74	Day 0	-0.32	Day 0	-0.33	Day 0	-0.89
Day 1	3.38	Day 1	6.25	Day 1	7.12	Day 1	54.75
Day 2	-3.53	Day 2	-2.55	Day 2	-1.75	Day 2	-12.58
Day 3	-0.18	Day 3	-0.54	Day 3	4.23	Day 3	-0.53
Day 4	-0.18	Day 4	-0.47	Day 4	-2.66	Day 4	4.43
Day 5	-0.31	Day 5	-0.57	Day 5	0.12	Day 5	-1.27
Day 6	-0.89	Day 6	-0.70	Day 6	-1.51	Day 6	5.46

Table 9 indicates an event that happened on 13.07.2023 when a U.S. judge ruled that Ripple (XRP) was not a security on exchanges. It caused Ripple (XRP) to surge (54.81% in daily returns). Prices of other selected cryptocurrencies also slightly increased in daily returns: Bitcoin (3.49%), Ethereum (6.86%) and Dogecoin (7.93%). The forecasted values display less positive numbers Bitcoin (-0.74%), Ethereum (-0.32%), Dogecoin (-0.33%) and Ripple (XRP) (-0.89%), consequently it is fair to conclude the announcement caused the price growth, so the event is considered positive.

Table 10. Market Behavior and Daily Returns for Cryptocurrencies Following Binance's Announcement on FTT Holdings and FTX's Bankruptcy (07.11.2022, Days -3 to 6)

EVENT	07.11.2022 Binance announced plans to sell its entire FTT holdings after criticism of FTX CEO Sam Bankman-Fried's regulatory stance. This caused FTT's price to plummet by 19% Type: Bankruptcy of a cryptocurrency exchange FTX						
IMPACT	Negative						
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	21145.9	Day - 3	1645.0	Day - 3	0.126109	Day - 3	0.5060
Day - 2	21301.6	Day - 2	1627.1	Day - 2	0.124469	Day - 2	0.4930
Day - 1	20916.3	Day - 1	1570.9	Day - 1	0.114755	Day - 1	0.4710
Day 0	20589.0	Day 0	1567.6	Day 0	0.111210	Day 0	0.4650
Day 1	18527.4	Day 1	1335.3	Day 1	0.088311	Day 1	0.4060
Day 2	15886.9	Day 2	1100.8	Day 2	0.074228	Day 2	0.3321
Day 3	17589.1	Day 3	1299.2	Day 3	0.089723	Day 3	0.3947
Day 4	17049.9	Day 4	1288.6	Day 4	0.085096	Day 4	0.3843
Day 5	16795.2	Day 5	1256.3	Day 5	0.088070	Day 5	0.3634
Day 6	16324.5	Day 6	1221.5	Day 6	0.084993	Day 6	0.3408

BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	20225.3	Day - 3	1531.7	Day - 3	0.123088	Day - 3	0.4550
Day - 2	21141.7	Day - 2	1636.2	Day - 2	0.125865	Day - 2	0.5060
Day - 1	21317.0	Day - 1	1629.0	Day - 1	0.124666	Day - 1	0.4931
Day 0	20946.1	Day 0	1577.0	Day 0	0.115805	Day 0	0.4711
Day 1	20617.7	Day 1	1569.5	Day 1	0.111728	Day 1	0.4651
Day 2	18600.7	Day 2	1356.8	Day 2	0.090712	Day 2	0.4061
Day 3	15976.2	Day 3	1124.3	Day 3	0.075935	Day 3	0.3322
Day 4	17567.1	Day 4	1285.0	Day 4	0.088401	Day 4	0.3947
Day 5	17082.7	Day 5	1289.4	Day 5	0.085484	Day 5	0.3844
Day 6	16822.1	Day 6	1260.3	Day 6	0.087869	Day 6	0.3635
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	0.73	Day - 2	-1.10	Day - 2	-1.31	Day - 2	-2.60
Day - 1	-1.83	Day - 1	-3.52	Day - 1	-8.13	Day - 1	-4.57
Day 0	-1.58	Day 0	-0.21	Day 0	-3.14	Day 0	-1.28
Day 1	-10.55	Day 1	-16.04	Day 1	-23.06	Day 1	-13.57
Day 2	-15.38	Day 2	-19.30	Day 2	-17.37	Day 2	-20.09
Day 3	10.18	Day 3	16.56	Day 3	18.96	Day 3	17.27
Day 4	-3.11	Day 4	-0.81	Day 4	-5.29	Day 4	-2.67
Day 5	-1.51	Day 5	-2.54	Day 5	3.44	Day 5	-5.59
Day 6	-2.84	Day 6	-2.81	Day 6	-3.56	Day 6	-6.42
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	4.43	Day - 2	6.60	Day - 2	2.23	Day - 2	10.62
Day - 1	0.83	Day - 1	-0.44	Day - 1	-0.96	Day - 1	-2.58
Day 0	-1.76	Day 0	-3.24	Day 0	-7.37	Day 0	-4.56
Day 1	-1.58	Day 1	-0.48	Day 1	-3.58	Day 1	-1.28
Day 2	-10.30	Day 2	-14.56	Day 2	-20.84	Day 2	-13.57
Day 3	-15.21	Day 3	-18.80	Day 3	-17.78	Day 3	-20.09
Day 4	9.49	Day 4	13.36	Day 4	15.20	Day 4	17.24

Day 5	-2.80	Day 5	0.34	Day 5	-3.36	Day 5	-2.64
Day 6	-1.54	Day 6	-2.28	Day 6	2.75	Day 6	-5.59

Table 10 displays, without a doubt, a negative event or rather a combination of them. The collapse of the cryptocurrency exchange FTX has started on 7 November 2022 with an official confirmation of Binance to sell its entire FTT holdings. However, the market did barely react on this announcement instantly (Day 0) and even forecasted daily returns display worse numbers: Bitcoin (-1.76%), Ethereum (-3.24%), Dogecoin (-7.37%), RIPPLE (XRP) (-4.56%). The next couple of days the market was struggling, as many investors were trying to sell their assets on the collapsing cryptocurrency exchange as well causing a slight instability on the other platforms. Three days after the announcement prices stabilized, as many investors decided to reinvest using other platforms, consequently prices increased.

Table 11. Market Behavior and Daily Returns for Cryptocurrencies Following the Russo-Ukrainian Conflict (24.02.2022, Days -3 to 6)

EVENT		24.02.2022 Russo-Ukrainian conflict Type: Black Swan					
IMPACT		Negative / Positive					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	37017.7	Day - 3	2569.9	Day - 3	0.128089	Day - 3	0.7016
Day - 2	38248.2	Day - 2	2636.1	Day - 2	0.131352	Day - 2	0.7212
Day - 1	37224.6	Day - 1	2578.2	Day - 1	0.127224	Day - 1	0.6960
Day 0	38339.2	Day 0	2596.5	Day 0	0.124013	Day 0	0.6960
Day 1	39209.6	Day 1	2767.5	Day 1	0.127659	Day 1	0.7693
Day 2	39115.5	Day 2	2777.0	Day 2	0.127596	Day 2	0.7504
Day 3	37689.1	Day 3	2616.3	Day 3	0.122963	Day 3	0.7214
Day 4	43188.2	Day 4	2922.5	Day 4	0.133469	Day 4	0.7813
Day 5	44420.3	Day 5	2975.8	Day 5	0.133951	Day 5	0.7838
Day 6	43912.8	Day 6	2947.1	Day 6	0.133033	Day 6	0.7688
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	38419.6	Day - 3	2633.4	Day - 3	0.137083	Day - 3	0.7757
Day - 2	37073.3	Day - 2	2576.5	Day - 2	0.129047	Day - 2	0.7018
Day - 1	38237.4	Day - 1	2632.0	Day - 1	0.131179	Day - 1	0.7213
Day 0	37270.1	Day 0	2584.0	Day 0	0.127678	Day 0	0.6961

Day 1	38331.2	Day 1	2596.5	Day 1	0.124438	Day 1	0.6961
Day 2	39206.5	Day 2	2753.7	Day 2	0.127394	Day 2	0.7693
Day 3	39137.3	Day 3	2776.0	Day 3	0.127634	Day 3	0.7505
Day 4	37745.9	Day 4	2631.4	Day 4	0.123488	Day 4	0.7215
Day 5	43067.6	Day 5	2898.2	Day 5	0.132528	Day 5	0.7813
Day 6	44405.0	Day 6	2970.2	Day 6	0.133866	Day 6	0.7839
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	3.27	Day - 2	2.55	Day - 2	2.52	Day - 2	2.76
Day - 1	-2.71	Day - 1	-2.22	Day - 1	-3.19	Day - 1	-3.56
Day 0	2.95	Day 0	0.71	Day 0	-2.56	Day 0	0.00
Day 1	2.24	Day 1	6.38	Day 1	2.90	Day 1	10.01
Day 2	-0.24	Day 2	0.34	Day 2	-0.05	Day 2	-2.49
Day 3	-3.71	Day 3	-5.96	Day 3	-3.70	Day 3	-3.94
Day 4	13.62	Day 4	11.07	Day 4	8.20	Day 4	7.98
Day 5	2.81	Day 5	1.81	Day 5	0.36	Day 5	0.32
Day 6	-1.15	Day 6	-0.97	Day 6	-0.69	Day 6	-1.93
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-3.57	Day - 2	-2.18	Day - 2	-6.04	Day - 2	-10.01
Day - 1	3.09	Day - 1	2.13	Day - 1	1.64	Day - 1	2.74
Day 0	-2.56	Day 0	-1.84	Day 0	-2.71	Day 0	-3.56
Day 1	2.81	Day 1	0.48	Day 1	-2.57	Day 1	0.00
Day 2	2.26	Day 2	5.88	Day 2	2.35	Day 2	10.00
Day 3	-0.18	Day 3	0.81	Day 3	0.19	Day 3	-2.47
Day 4	-3.62	Day 4	-5.35	Day 4	-3.30	Day 4	-3.94
Day 5	13.19	Day 5	9.66	Day 5	7.06	Day 5	7.96
Day 6	3.06	Day 6	2.45	Day 6	1.00	Day 6	0.33

Table 11 displays what happened to the selected cryptocurrencies when a Black Swan event, such as the military conflict between the Russian Federation and Ukraine, was announced on 24 February 2022. Markets of at least two countries involved into the conflict almost collapsed causing lots of issues for the investors worldwide.

Selected cryptocurrencies also lost their values, however for a short period of time when Bitcoin was trading at approximately \$34000 USD so was a decline for more than 8% compared to the day earlier [70]. The same day when sanctions against Russia were announced Bitcoin did turn positive and only Dogecoin lost in daily returns (-2.56%) considering closing prices of the Day 0 [71]. Forecasted daily returns show worse results Bitcoin (-2.56%), Ethereum (-1.84%), Dogecoin (-2.71%), RIPPLE (XRP) (-3.56%). Consequently, the event that is supposed to be considered negative turned out positive for the cryptocurrency market. The idea of applying financial sanctions such as: asset freezes, SWIFT restrictions, central bank sanctions, banking sector restrictions, ban on dollar and euro banknotes export to Russia etc. rather had a negative impact on the global financial system undermining trust in following international currencies. Cryptocurrencies, on the other hand, were otherwise gaining more trust helping civil people and companies that were not even involved in the political process to save their capitals and to be able to make worldwide transactions. The following example displays how two both negative but contrary announcements (in terms of the sides of the conflict) can suddenly become positive for a particular market and how difficult to evaluate the impact of a certain announcement.

Table 12. Market Behavior and Daily Returns for Cryptocurrencies Following Musk's Tweet on Tesla and Bitcoin (12.05.2021, Days -3 to 6)

EVENT		12.05.2021 Tweet: Musk announced Tesla would stop accepting Bitcoin over environmental concerns. Type: Tweet of an opinion leader					
IMPACT		Negative					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	58238.3	Day - 3	3922.2	Day - 3	0.568682	Day - 3	1.5345
Day - 2	55848.9	Day - 2	3947.9	Day - 2	0.449977	Day - 2	1.3910
Day - 1	56695.7	Day - 1	4167.8	Day - 1	0.493231	Day - 1	1.4780
Day 0	49384.2	Day 0	3811.8	Day 0	0.389159	Day 0	1.2683
Day 1	49704.6	Day 1	3719.6	Day 1	0.486910	Day 1	1.3614
Day 2	49839.8	Day 2	4075.4	Day 2	0.559581	Day 2	1.4034
Day 3	46708.8	Day 3	3641.7	Day 3	0.507448	Day 3	1.4859
Day 4	46426.4	Day 4	3582.1	Day 4	0.513023	Day 4	1.4497
Day 5	43541.3	Day 5	3279.7	Day 5	0.486366	Day 5	1.4959
Day 6	42897.3	Day 6	3377.6	Day 6	0.474714	Day 6	1.5905

BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	58820.8	Day - 3	3869.8	Day - 3	0.638705	Day - 3	1.5625
Day - 2	58272.8	Day - 2	3918.8	Day - 2	0.575749	Day - 2	1.5346
Day - 1	55930.8	Day - 1	3946.5	Day - 1	0.462622	Day - 1	1.3913
Day 0	56695.5	Day 0	4149.6	Day 0	0.490227	Day 0	1.4780
Day 1	49591.8	Day 1	3842.4	Day 1	0.399332	Day 1	1.2686
Day 2	49721.2	Day 2	3731.4	Day 2	0.478205	Day 2	1.3614
Day 3	49856.2	Day 3	4046.5	Day 3	0.551496	Day 3	1.4034
Day 4	46809.3	Day 4	3678.1	Day 4	0.511915	Day 4	1.4859
Day 5	46455.7	Day 5	3591.6	Day 5	0.512971	Day 5	1.4498
Day 6	43635.8	Day 6	3308.0	Day 6	0.489087	Day 6	1.4959
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-4.19	Day - 2	0.65	Day - 2	-23.41	Day - 2	-9.82
Day - 1	1.50	Day - 1	5.42	Day - 1	9.18	Day - 1	6.07
Day 0	-13.81	Day 0	-8.93	Day 0	-23.70	Day 0	-15.30
Day 1	0.65	Day 1	-2.45	Day 1	22.41	Day 1	7.08
Day 2	0.27	Day 2	9.13	Day 2	13.91	Day 2	3.04
Day 3	-6.49	Day 3	-11.25	Day 3	-9.78	Day 3	5.71
Day 4	-0.61	Day 4	-1.65	Day 4	1.09	Day 4	-2.47
Day 5	-6.42	Day 5	-8.82	Day 5	-5.34	Day 5	3.14
Day 6	-1.49	Day 6	2.94	Day 6	-2.42	Day 6	6.13
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-0.94	Day - 2	1.26	Day - 2	-10.38	Day - 2	-1.80
Day - 1	-4.10	Day - 1	0.70	Day - 1	-21.88	Day - 1	-9.80
Day 0	1.36	Day 0	5.02	Day 0	5.80	Day 0	6.05
Day 1	-13.39	Day 1	-7.69	Day 1	-20.51	Day 1	-15.28
Day 2	0.26	Day 2	-2.93	Day 2	18.02	Day 2	7.06
Day 3	0.27	Day 3	8.11	Day 3	14.26	Day 3	3.04
Day 4	-6.31	Day 4	-9.55	Day 4	-7.45	Day 4	5.71

Day 5	-0.76	Day 5	-2.38	Day 5	0.21	Day 5	-2.46
Day 6	-6.26	Day 6	-8.23	Day 6	-4.77	Day 6	3.13

Table 12 indicates the market behavior on the Elon Musk's tweet he published on 12 May 2021. In his messages he announced that Tesla (Elon Musk is its CEO that owns 13% of the company) would stop accepting Bitcoin over environmental concerns [72]. The following tweet caused a significant price drop for every observed cryptocurrency. Daily return forecast otherwise displays positive numbers: Bitcoin (1.36%), Ethereum (5.02%), Dogecoin (5.80%), RIPPLE (XRP) (6.05%) meaning the event could have been one of the key reasons for the price decrease. However, there are always other factors to consider, at the same time the particular event is surely considered negative.

Table 13. Market Behavior and Daily Returns for Cryptocurrencies Following Musk's «The Dogefather» Tweet (28.04.2021, Days -3 to 6)

EVENT		28.04.2021 Tweet: Musk referred to himself as "The Dogefather" ahead of his SNL appearance. Type: Tweet of an opinion leader					
IMPACT		Positive					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	48963.6	Day - 3	2316.5	Day - 3	0.251103	Day - 3	1.0338
Day - 2	54020.5	Day - 2	2533.1	Day - 2	0.269805	Day - 2	1.3670
Day - 1	55036.5	Day - 1	2665.2	Day - 1	0.270668	Day - 1	1.4017
Day 0	54841.4	Day 0	2746.5	Day 0	0.323582	Day 0	1.3580
Day 1	53560.8	Day 1	2757.4	Day 1	0.303240	Day 1	1.3981
Day 2	57720.3	Day 2	2772.8	Day 2	0.336635	Day 2	1.5971
Day 3	57807.1	Day 3	2944.7	Day 3	0.390642	Day 3	1.6507
Day 4	56603.8	Day 4	2950.3	Day 4	0.372404	Day 4	1.5611
Day 5	57169.8	Day 5	3429.4	Day 5	0.438244	Day 5	1.5547
Day 6	53741.5	Day 6	3286.7	Day 6	0.559005	Day 6	1.3966
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	50136.5	Day - 3	2230.6	Day - 3	0.268120	Day - 3	1.0503
Day - 2	49013.3	Day - 2	2310.1	Day - 2	0.252864	Day - 2	1.0339
Day - 1	53911.1	Day - 1	2514.8	Day - 1	0.268168	Day - 1	1.3667
Day 0	55027.0	Day 0	2653.2	Day 0	0.270476	Day 0	1.4018

Day 1	54865.7	Day 1	2739.5	Day 1	0.318326	Day 1	1.3581
Day 2	53613.9	Day 2	2756.9	Day 2	0.304808	Day 2	1.3982
Day 3	57634.1	Day 3	2772.5	Day 3	0.333508	Day 3	1.5970
Day 4	57822.1	Day 4	2930.8	Day 4	0.384983	Day 4	1.6507
Day 5	56654.6	Day 5	2949.7	Day 5	0.373721	Day 5	1.5613
Day 6	57176.0	Day 6	3388.6	Day 6	0.431846	Day 6	1.5548
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	9.83	Day - 2	8.94	Day - 2	7.18	Day - 2	27.94
Day - 1	1.86	Day - 1	5.08	Day - 1	0.32	Day - 1	2.51
Day 0	-0.36	Day 0	3.00	Day 0	17.86	Day 0	-3.17
Day 1	-2.36	Day 1	0.39	Day 1	-6.49	Day 1	2.91
Day 2	7.48	Day 2	0.56	Day 2	10.45	Day 2	13.31
Day 3	0.15	Day 3	6.01	Day 3	14.88	Day 3	3.30
Day 4	-2.10	Day 4	0.19	Day 4	-4.78	Day 4	-5.58
Day 5	0.99	Day 5	15.05	Day 5	16.28	Day 5	-0.41
Day 6	-6.18	Day 6	-4.25	Day 6	24.34	Day 6	-10.72
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-2.27	Day - 2	3.50	Day - 2	-5.86	Day - 2	-1.57
Day - 1	9.52	Day - 1	8.49	Day - 1	5.88	Day - 1	27.91
Day 0	2.05	Day 0	5.36	Day 0	0.86	Day 0	2.54
Day 1	-0.29	Day 1	3.20	Day 1	16.29	Day 1	-3.17
Day 2	-2.31	Day 2	0.63	Day 2	-4.34	Day 2	2.91
Day 3	7.23	Day 3	0.56	Day 3	9.00	Day 3	13.29
Day 4	0.33	Day 4	5.55	Day 4	14.35	Day 4	3.31
Day 5	-2.04	Day 5	0.64	Day 5	-2.97	Day 5	-5.57
Day 6	0.92	Day 6	13.87	Day 6	14.46	Day 6	-0.42

Table 13 shows how the market reacted on Elon Musk's tweet where he referred to himself as "The Dogefather" highlighting the cryptocurrency Dogecoin. The event is considered positive, but it only had a significant impact on Dogecoin itself increasing its daily returns (Day 0) by almost 18% (forecasted value 0,86%) keeping

a very positive trend next 6 days apart from the 1st and the 4th ones after the announcement, however the following event had a visible impact only on this particular cryptocurrency. Consequently, it is fair to conclude that there were no other significant factors to increase the price aside from the observed tweet.

Table 14. Market Behavior and Daily Returns for Cryptocurrencies Following Musk's 'DogeCoin on the Moon' Tweet (01.04.2021, Days -3 to 6)

EVENT		01.04.2021 Tweet: Musk announced SpaceX would put a "literal Dogecoin on the literal moon." Type: Tweet of an opinion leader							
IMPACT		Positive							
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)			
Day - 3	57616.2	Day - 3	1816.7	Day - 3	0.054102	Day - 3	0.5654		
Day - 2	58771.3	Day - 2	1841.0	Day - 2	0.054027	Day - 2	0.5622		
Day - 1	58763.7	Day - 1	1918.0	Day - 1	0.053744	Day - 1	0.5696		
Day 0	58718.3	Day 0	1968.0	Day 0	0.062113	Day 0	0.5705		
Day 1	58977.3	Day 1	2134.6	Day 1	0.057570	Day 1	0.6068		
Day 2	57059.9	Day 2	2008.6	Day 2	0.055554	Day 2	0.5789		
Day 3	58199.9	Day 3	2075.9	Day 3	0.057401	Day 3	0.6349		
Day 4	58993.4	Day 4	2106.4	Day 4	0.059948	Day 4	0.9132		
Day 5	57996.3	Day 5	2111.5	Day 5	0.064283	Day 5	1.0906		
Day 6	55948.7	Day 6	1961.5	Day 6	0.058728	Day 6	0.9166		
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)			
Day - 3	55787.1	Day - 3	1690.1	Day - 3	0.053773	Day - 3	0.5458		
Day - 2	57588.6	Day - 2	1806.8	Day - 2	0.054127	Day - 2	0.5654		
Day - 1	58760.4	Day - 1	1839.1	Day - 1	0.054095	Day - 1	0.5623		
Day 0	58783.1	Day 0	1912.2	Day 0	0.053837	Day 0	0.5697		
Day 1	58739.5	Day 1	1964.2	Day 1	0.061342	Day 1	0.5706		
Day 2	58990.7	Day 2	2120.8	Day 2	0.058005	Day 2	0.6068		
Day 3	57129.1	Day 3	2019.5	Day 3	0.055857	Day 3	0.5790		
Day 4	58191.8	Day 4	2072.1	Day 4	0.057304	Day 4	0.6349		
Day 5	58992.3	Day 5	2104.5	Day 5	0.059741	Day 5	0.9130		
Day 6	58041.4	Day 6	2112.0	Day 6	0.063886	Day 6	1.0905		
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)			

Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	1.98	Day - 2	1.33	Day - 2	-0.14	Day - 2	-0.57
Day - 1	-0.01	Day - 1	4.10	Day - 1	-0.53	Day - 1	1.31
Day 0	-0.08	Day 0	2.57	Day 0	14.47	Day 0	0.16
Day 1	0.44	Day 1	8.13	Day 1	-7.60	Day 1	6.17
Day 2	-3.31	Day 2	-6.08	Day 2	-3.56	Day 2	-4.71
Day 3	1.98	Day 3	3.30	Day 3	3.27	Day 3	9.23
Day 4	1.35	Day 4	1.46	Day 4	4.34	Day 4	36.35
Day 5	-1.70	Day 5	0.24	Day 5	6.98	Day 5	17.75
Day 6	-3.59	Day 6	-7.37	Day 6	-9.04	Day 6	-17.38
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	3.18	Day - 2	6.68	Day - 2	0.66	Day - 2	3.53
Day - 1	2.01	Day - 1	1.77	Day - 1	-0.06	Day - 1	-0.55
Day 0	0.04	Day 0	3.90	Day 0	-0.48	Day 0	1.31
Day 1	-0.07	Day 1	2.68	Day 1	13.05	Day 1	0.16
Day 2	0.43	Day 2	7.67	Day 2	-5.59	Day 2	6.15
Day 3	-3.21	Day 3	-4.89	Day 3	-3.77	Day 3	-4.69
Day 4	1.84	Day 4	2.57	Day 4	2.56	Day 4	9.22
Day 5	1.37	Day 5	1.55	Day 5	4.16	Day 5	36.33
Day 6	-1.63	Day 6	0.36	Day 6	6.71	Day 6	17.77

Table 14 like Table 13 displays the behavior of the market on Elon Musk's tweet where he announced that SpaceX would put a "literal Dogecoin on the literal moon" he posted on 1 April 2021. Similarly to the announcement he posted later on 28 April 2021 it only directly affected Dogecoin in a positive way increasing its daily returns by 14.47% (Day 0) (forecasted value -0.48%). There is no visible evidence three other currencies reacting on it, therefore it is fair to consider the following event was the key reason for Dogecoin to surge in price.

Table 15. Market Behavior and Daily Returns for Cryptocurrencies Following Tesla's \$1.5B Bitcoin Investment Announcement (08.02.2021, Days -3 to 6)

EVENT	08.02.2021 Tweet: Tesla announced a \$1.5B Bitcoin investment and acceptance as payment. Type: Tweet of a company
IMPACT	Positive

BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	38297.6	Day - 3	1719.2	Day - 3	0.046783	Day - 3	0.4518
Day - 2	39256.6	Day - 2	1676.6	Day - 2	0.057465	Day - 2	0.4427
Day - 1	38852.9	Day - 1	1613.0	Day - 1	0.078508	Day - 1	0.4184
Day 0	46395.7	Day 0	1750.2	Day 0	0.078793	Day 0	0.4508
Day 1	46508.6	Day 1	1770.6	Day 1	0.070012	Day 1	0.4764
Day 2	44836.0	Day 2	1742.1	Day 2	0.072584	Day 2	0.5047
Day 3	47990.7	Day 3	1786.4	Day 3	0.069611	Day 3	0.5282
Day 4	47371.7	Day 4	1841.0	Day 4	0.069791	Day 4	0.6089
Day 5	47168.7	Day 5	1815.5	Day 5	0.066249	Day 5	0.6330
Day 6	48643.4	Day 6	1801.8	Day 6	0.062639	Day 6	0.5925
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	37017.7	Day - 3	1600.1	Day - 3	0.051390	Day - 3	0.4443
Day - 2	38284.2	Day - 2	1709.9	Day - 2	0.047302	Day - 2	0.4519
Day - 1	39251.1	Day - 1	1680.6	Day - 1	0.056506	Day - 1	0.4428
Day 0	38882.6	Day 0	1620.0	Day 0	0.076364	Day 0	0.4185
Day 1	46221.9	Day 1	1739.9	Day 1	0.078608	Day 1	0.4508
Day 2	46520.7	Day 2	1769.1	Day 2	0.070930	Day 2	0.4764
Day 3	44898.8	Day 3	1745.6	Day 3	0.072476	Day 3	0.5047
Day 4	47930.6	Day 4	1783.9	Day 4	0.069955	Day 4	0.5282
Day 5	47405.6	Day 5	1837.2	Day 5	0.069865	Day 5	0.6089
Day 6	47194.3	Day 6	1818.5	Day 6	0.066669	Day 6	0.6330
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	2.47	Day - 2	-2.51	Day - 2	20.57	Day - 2	-2.03
Day - 1	-1.03	Day - 1	-3.87	Day - 1	31.20	Day - 1	-5.65
Day 0	17.74	Day 0	8.16	Day 0	0.36	Day 0	7.46
Day 1	0.24	Day 1	1.16	Day 1	-11.82	Day 1	5.52
Day 2	-3.66	Day 2	-1.62	Day 2	3.61	Day 2	5.77
Day 3	6.80	Day 3	2.51	Day 3	-4.18	Day 3	4.55
Day 4	-1.30	Day 4	3.01	Day 4	0.26	Day 4	14.22
Day 5	-0.43	Day 5	-1.40	Day 5	-5.21	Day 5	3.88
Day 6	3.08	Day 6	-0.76	Day 6	-5.60	Day 6	-6.61

BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	3.36	Day - 2	6.64	Day - 2	-8.29	Day - 2	1.70
Day - 1	2.49	Day - 1	-1.73	Day - 1	17.78	Day - 1	-2.03
Day 0	-0.94	Day 0	-3.67	Day 0	30.12	Day 0	-5.64
Day 1	17.29	Day 1	7.14	Day 1	2.90	Day 1	7.43
Day 2	0.64	Day 2	1.66	Day 2	-10.28	Day 2	5.52
Day 3	-3.55	Day 3	-1.34	Day 3	2.16	Day 3	5.77
Day 4	6.53	Day 4	2.17	Day 4	-3.54	Day 4	4.55
Day 5	-1.10	Day 5	2.94	Day 5	-0.13	Day 5	14.22
Day 6	-0.45	Day 6	-1.02	Day 6	-4.68	Day 6	3.88

Table 15 displays the reaction of the market on a positive announcement posted on twitter by Tesla corporation on 8 February 2021. In the following post the company announced \$1.5 Billion dollars investment in Bitcoin and its acceptance as a payment method. Bitcoin daily returns were estimated at 17.74% (Day 0) (forecasted value: -0.94%). Other selected cryptocurrencies still display positive numbers, especially considering forecasted values, however nothing extraordinary compared to Bitcoins price surge. Additionally, Dogecoin's daily returns look interesting (0.36%) (Day 0) especially taking into consideration the fact how often Elon Musk (Tesla inc. CEO) was promoting it before the following announcement.

Table 16. Market Behavior and Daily Returns for Cryptocurrencies Following Musk's '#Bitcoin' Twitter Bio Update (29.01.2021, Days -3 to 6)

EVENT	29.01.2021 Tweet: Musk added “#Bitcoin” to his Twitter bio. Type: Tweet of an opinion leader						
IMPACT	Positive						
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	32502.1	Day - 3	1366.3	Day - 3	0.008240	Day - 3	0.2684
Day - 2	30404.0	Day - 2	1247.6	Day - 2	0.007441	Day - 2	0.2507
Day - 1	33374.8	Day - 1	1328.5	Day - 1	0.036265	Day - 1	0.2641
Day 0	34301.8	Day 0	1379.3	Day 0	0.046597	Day 0	0.2828
Day 1	34283.1	Day 1	1377.0	Day 1	0.028197	Day 1	0.4430

Day 2	33108.1	Day 2	1312.7	Day 2	0.036841	Day 2	0.4949
Day 3	33515.7	Day 3	1373.4	Day 3	0.034705	Day 3	0.3716
Day 4	35485.2	Day 4	1511.4	Day 4	0.031296	Day 4	0.3723
Day 5	37646.8	Day 5	1664.3	Day 5	0.037345	Day 5	0.3973
Day 6	36982.1	Day 6	1594.0	Day 6	0.052944	Day 6	0.4443
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	32271.9	Day - 3	1324.2	Day - 3	0.008452	Day - 3	0.2677
Day - 2	32515.7	Day - 2	1363.7	Day - 2	0.008319	Day - 2	0.2685
Day - 1	30477.8	Day - 1	1258.9	Day - 1	0.007586	Day - 1	0.2508
Day 0	33319.7	Day 0	1323.5	Day 0	0.033453	Day 0	0.2641
Day 1	34296.0	Day 1	1375.5	Day 1	0.045339	Day 1	0.2828
Day 2	34302.9	Day 2	1378.0	Day 2	0.029970	Day 2	0.4429
Day 3	33158.3	Day 3	1319.5	Day 3	0.036211	Day 3	0.4949
Day 4	33526.0	Day 4	1369.8	Day 4	0.034913	Day 4	0.3718
Day 5	35454.3	Day 5	1500.1	Day 5	0.031716	Day 5	0.3724
Day 6	37609.9	Day 6	1651.1	Day 6	0.036839	Day 6	0.3973
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-6.67	Day - 2	-9.08	Day - 2	-10.20	Day - 2	-6.82
Day - 1	9.32	Day - 1	6.28	Day - 1	158.38	Day - 1	5.21
Day 0	2.74	Day 0	3.75	Day 0	25.07	Day 0	6.84
Day 1	-0.05	Day 1	-0.17	Day 1	-50.23	Day 1	44.88
Day 2	-3.49	Day 2	-4.78	Day 2	26.74	Day 2	11.08
Day 3	1.22	Day 3	4.52	Day 3	-5.97	Day 3	-28.65
Day 4	5.71	Day 4	9.57	Day 4	-10.34	Day 4	0.19
Day 5	5.91	Day 5	9.64	Day 5	17.67	Day 5	6.50
Day 6	-1.78	Day 6	-4.32	Day 6	34.90	Day 6	11.18
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	0.75	Day - 2	2.94	Day - 2	-1.59	Day - 2	0.30
Day - 1	-6.47	Day - 1	-8.00	Day - 1	-9.22	Day - 1	-6.82

Day 0	8.92	Day 0	5.00	Day 0	148.38	Day 0	5.17
Day 1	2.89	Day 1	3.85	Day 1	30.40	Day 1	6.84
Day 2	0.02	Day 2	0.18	Day 2	-41.40	Day 2	44.86
Day 3	-3.39	Day 3	-4.34	Day 3	18.92	Day 3	11.10
Day 4	1.10	Day 4	3.74	Day 4	-3.65	Day 4	-28.60
Day 5	5.59	Day 5	9.09	Day 5	-9.60	Day 5	0.16
Day 6	5.90	Day 6	9.59	Day 6	14.97	Day 6	6.47

Table 16 shows the result of another Elon Musk's activity in twitter on 29 January 2021. Once he added “#Bitcoin” to his twitter bio the price of Bitcoin surged from around \$32,000 USD to \$37500 USD within only an hour [73]. However, later on the price stabilized and the closing price was estimated at \$34,301.8 USD (daily returns only increased by 2.74%). Dogecoin, at the same time, increased its daily returns by impressive 25.07% due to his previous promotions of this cryptocurrency. No other selected currencies showed an abnormal price growth; therefore, it is fair to conclude the post significantly influenced the price of the following two cryptocurrencies.

Table 17. Market Behavior and Daily Returns for Cryptocurrencies Following the SEC's Lawsuit Against Ripple (22.12.2020, Days -3 to 6)

EVENT		22.12.2020 The SEC's lawsuit against Ripple over XRP as an unregistered security caused XRP's price to plummet and raised broader concerns about crypto regulation. Type: Regulatory action					
IMPACT		Negative					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	23844.0	Day - 3	658.2	Day - 3	0.003925	Day - 3	0.5766
Day - 2	23474.9	Day - 2	638.3	Day - 2	0.004641	Day - 2	0.5563
Day - 1	22728.5	Day - 1	607.9	Day - 1	0.004773	Day - 1	0.5145
Day 0	23823.2	Day 0	637.5	Day 0	0.004514	Day 0	0.4473
Day 1	23257.9	Day 1	585.7	Day 1	0.003767	Day 1	0.2604
Day 2	23736.5	Day 2	612.3	Day 2	0.004573	Day 2	0.3378
Day 3	24689.6	Day 3	626.9	Day 3	0.004563	Day 3	0.3182
Day 4	26454.4	Day 4	636.6	Day 4	0.004508	Day 4	0.2946
Day 5	26261.3	Day 5	683.7	Day 5	0.004548	Day 5	0.2839
Day 6	27057.8	Day 6	730.1	Day 6	0.004594	Day 6	0.2493

BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	23139.1	Day - 3	654.1	Day - 3	0.003910	Day - 3	0.5836
Day - 2	23845.3	Day - 2	658.9	Day - 2	0.003981	Day - 2	0.5767
Day - 1	23503.9	Day - 1	641.2	Day - 1	0.004633	Day - 1	0.5564
Day 0	22767.9	Day 0	611.9	Day 0	0.004817	Day 0	0.5146
Day 1	23815.5	Day 1	636.3	Day 1	0.004602	Day 1	0.4474
Day 2	23291.7	Day 2	591.2	Day 2	0.003908	Day 2	0.2607
Day 3	23744.5	Day 3	611.6	Day 3	0.004564	Day 3	0.3378
Day 4	24684.8	Day 4	626.7	Day 4	0.004621	Day 4	0.3183
Day 5	26428.3	Day 5	636.8	Day 5	0.004577	Day 5	0.2947
Day 6	26285.1	Day 6	680.7	Day 6	0.004608	Day 6	0.2840
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-1.56	Day - 2	-3.07	Day - 2	16.76	Day - 2	-3.58
Day - 1	-3.23	Day - 1	-4.88	Day - 1	2.80	Day - 1	-7.81
Day 0	4.70	Day 0	4.76	Day 0	-5.58	Day 0	-14.00
Day 1	-2.40	Day 1	-8.47	Day 1	-18.09	Day 1	-54.10
Day 2	2.04	Day 2	4.45	Day 2	19.39	Day 2	26.02
Day 3	3.94	Day 3	2.35	Day 3	-0.22	Day 3	-5.98
Day 4	6.90	Day 4	1.53	Day 4	-1.21	Day 4	-7.71
Day 5	-0.73	Day 5	7.14	Day 5	0.88	Day 5	-3.70
Day 6	2.99	Day 6	6.56	Day 6	1.01	Day 6	-13.00
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	3.01	Day - 2	0.73	Day - 2	1.80	Day - 2	-1.19
Day - 1	-1.44	Day - 1	-2.72	Day - 1	15.17	Day - 1	-3.58
Day 0	-3.18	Day 0	-4.68	Day 0	3.89	Day 0	-7.81
Day 1	4.50	Day 1	3.91	Day 1	-4.57	Day 1	-13.99
Day 2	-2.22	Day 2	-7.35	Day 2	-16.35	Day 2	-54.01
Day 3	1.93	Day 3	3.39	Day 3	15.52	Day 3	25.91
Day 4	3.88	Day 4	2.44	Day 4	1.24	Day 4	-5.95

Day 5	6.82	Day 5	1.60	Day 5	-0.96	Day 5	-7.70
Day 6	-0.54	Day 6	6.67	Day 6	0.68	Day 6	-3.70

The result of a regulatory action displayed in the Table 17 and how it affected the market. The event is considered negative and mostly touches RIPPLE (XRP), but still raised broader concerns about cryptocurrency regulations. On 22 December 2020 the U.S. Securities and Exchange Commission (SEC) accused Ripple Labs and its executives of raising over \$1.3 billion through the sale of XRP, which the SEC classified as an unregistered security, consequently the price of RIPPLE dropped from \$0.5145 USD to \$0.4473 USD and then even to \$0.2607 USD (Daily returns: Day 0: -14.00%; Day 1: -54.10%). However, only two days after the currency bounced back (Daily returns: Day 2: 26.02%). Additionally, stable coins didn't show a significant drop, but Dogecoin lost in daily returns a bit more than 18% along with falling down RIPPLE meaning the lack of stability of small coins.

Table 18. Market Behavior and Daily Returns for Cryptocurrencies Following Musk's «One word: Doge» Tweet (20.12.2020, Days -3 to 6)

EVENT		20.12.2020 Tweet: Musk tweeted, "One word: Doge." Type: Tweet of an opinion leader					
IMPACT		Positive					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	22825.4	Day - 3	643.2	Day - 3	0.003723	Day - 3	0.5779
Day - 2	23127.9	Day - 2	653.9	Day - 2	0.003863	Day - 2	0.5835
Day - 1	23844.0	Day - 1	658.2	Day - 1	0.003925	Day - 1	0.5766
Day 0	23474.9	Day 0	638.3	Day 0	0.004641	Day 0	0.5563
Day 1	22728.5	Day 1	607.9	Day 1	0.004773	Day 1	0.5145
Day 2	23823.2	Day 2	637.5	Day 2	0.004514	Day 2	0.4473
Day 3	23257.9	Day 3	585.7	Day 3	0.003767	Day 3	0.2604
Day 4	23736.5	Day 4	612.3	Day 4	0.004573	Day 4	0.3378
Day 5	24689.6	Day 5	626.9	Day 5	0.004563	Day 5	0.3182
Day 6	26454.4	Day 6	636.6	Day 6	0.004508	Day 6	0.2946
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	21322.7	Day - 3	634.4	Day - 3	0.003465	Day - 3	0.5711

Day - 2	22806.2	Day - 2	643.5	Day - 2	0.003755	Day - 2	0.5780
Day - 1	23139.1	Day - 1	654.1	Day - 1	0.003910	Day - 1	0.5836
Day 0	23845.3	Day 0	658.9	Day 0	0.003981	Day 0	0.5767
Day 1	23503.9	Day 1	641.2	Day 1	0.004633	Day 1	0.5564
Day 2	22767.9	Day 2	611.9	Day 2	0.004817	Day 2	0.5146
Day 3	23815.5	Day 3	636.3	Day 3	0.004602	Day 3	0.4474
Day 4	23291.7	Day 4	591.2	Day 4	0.003908	Day 4	0.2607
Day 5	23744.5	Day 5	611.6	Day 5	0.004564	Day 5	0.3378
Day 6	24684.8	Day 6	626.7	Day 6	0.004621	Day 6	0.3183
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	1.32	Day - 2	1.65	Day - 2	3.69	Day - 2	0.96
Day - 1	3.05	Day - 1	0.66	Day - 1	1.59	Day - 1	-1.19
Day 0	-1.56	Day 0	-3.07	Day 0	16.76	Day 0	-3.58
Day 1	-3.23	Day 1	-4.88	Day 1	2.80	Day 1	-7.81
Day 2	4.70	Day 2	4.76	Day 2	-5.58	Day 2	-14.00
Day 3	-2.40	Day 3	-8.47	Day 3	-18.09	Day 3	-54.10
Day 4	2.04	Day 4	4.45	Day 4	19.39	Day 4	26.02
Day 5	3.94	Day 5	2.35	Day 5	-0.22	Day 5	-5.98
Day 6	6.90	Day 6	1.53	Day 6	-1.21	Day 6	-7.71
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	6.73	Day - 2	1.42	Day - 2	8.04	Day - 2	1.20
Day - 1	1.45	Day - 1	1.63	Day - 1	4.04	Day - 1	0.96
Day 0	3.01	Day 0	0.73	Day 0	1.80	Day 0	-1.19
Day 1	-1.44	Day 1	-2.72	Day 1	15.17	Day 1	-3.58
Day 2	-3.18	Day 2	-4.68	Day 2	3.89	Day 2	-7.81
Day 3	4.50	Day 3	3.91	Day 3	-4.57	Day 3	-13.99
Day 4	-2.22	Day 4	-7.35	Day 4	-16.35	Day 4	-54.01
Day 5	1.93	Day 5	3.39	Day 5	15.52	Day 5	25.91
Day 6	3.88	Day 6	2.44	Day 6	1.24	Day 6	-5.95

On 20 December 2020 Elon Musk tweeted, "One word: Doge." in his account highlighting Dogecoin itself. Table 18 indicates the behavior of the market on the

following tweet. On the day the announcement was made all the observed cryptocurrencies slightly lost their value, apart from Dogecoin that increased in price from \$0.003925 USD to \$0.004641 USD (Day 0 daily returns: 16.76). Forecasted values look stable and it doesn't look like there were other visible factors responsible for this rise, therefore it is fair to conclude the following price growth was exclusively due to the tweet.

Table 19. Market Behavior and Daily Returns for Cryptocurrencies During the COVID-19 Market Crash (12.03.2020, Days -3 to 6)

EVENT		12.03.2020 The COVID-19 pandemic caused a market crash, with Bitcoin dropping over 50% in a day, revealing its strong correlation with traditional markets in crises. Type: Black Swan					
IMPACT		Negative / Positive					
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)	
Day - 3	7933.0	Day - 3	202.9	Day - 3	0.002222	Day - 3	0.2096
Day - 2	7891.2	Day - 2	200.6	Day - 2	0.002205	Day - 2	0.2117
Day - 1	7935.1	Day - 1	194.6	Day - 1	0.002176	Day - 1	0.2081
Day 0	4826.0	Day 0	107.9	Day 0	0.001585	Day 0	0.1360
Day 1	5584.3	Day 1	134.0	Day 1	0.001753	Day 1	0.1588
Day 2	5182.7	Day 2	122.7	Day 2	0.001687	Day 2	0.1460
Day 3	5366.3	Day 3	124.4	Day 3	0.001695	Day 3	0.1531
Day 4	5030.0	Day 4	111.0	Day 4	0.001637	Day 4	0.1409
Day 5	5261.1	Day 5	116.1	Day 5	0.001703	Day 5	0.1472
Day 6	5361.4	Day 6	117.8	Day 6	0.001672	Day 6	0.1475
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)	
Day - 3	8076.2	Day - 3	203.8	Day - 3	0.002266	Day - 3	0.2039
Day - 2	7956.2	Day - 2	204.0	Day - 2	0.002284	Day - 2	0.2097
Day - 1	7912.3	Day - 1	202.0	Day - 1	0.002271	Day - 1	0.2118
Day 0	7954.0	Day 0	196.3	Day 0	0.002243	Day 0	0.2082
Day 1	4926.0	Day 1	116.7	Day 1	0.001708	Day 1	0.1361
Day 2	5586.8	Day 2	133.6	Day 2	0.001806	Day 2	0.1588
Day 3	5212.6	Day 3	124.8	Day 3	0.001757	Day 3	0.1461
Day 4	5381.8	Day 4	125.5	Day 4	0.001759	Day 4	0.1531
Day 5	5058.5	Day 5	113.4	Day 5	0.001707	Day 5	0.1410
Day 6	5275.4	Day 6	116.9	Day 6	0.001761	Day 6	0.1472

BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-0.53	Day - 2	-1.14	Day - 2	-0.77	Day - 2	1.00
Day - 1	0.55	Day - 1	-3.03	Day - 1	-1.32	Day - 1	-1.72
Day 0	-49.73	Day 0	-58.96	Day 0	-31.69	Day 0	-42.54
Day 1	14.59	Day 1	21.66	Day 1	10.07	Day 1	15.50
Day 2	-7.46	Day 2	-8.81	Day 2	-3.84	Day 2	-8.40
Day 3	3.48	Day 3	1.34	Day 3	0.47	Day 3	4.75
Day 4	-6.47	Day 4	-11.34	Day 4	-3.48	Day 4	-8.30
Day 5	4.49	Day 5	4.44	Day 5	3.95	Day 5	4.37
Day 6	1.89	Day 6	1.46	Day 6	-1.84	Day 6	0.20
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	-1.50	Day - 2	0.10	Day - 2	0.79	Day - 2	2.80
Day - 1	-0.55	Day - 1	-0.99	Day - 1	-0.57	Day - 1	1.00
Day 0	0.53	Day 0	-2.86	Day 0	-1.24	Day 0	-1.71
Day 1	-47.91	Day 1	-52.00	Day 1	-27.25	Day 1	-42.51
Day 2	12.59	Day 2	13.52	Day 2	5.58	Day 2	15.43
Day 3	-6.93	Day 3	-6.81	Day 3	-2.75	Day 3	-8.34
Day 4	3.19	Day 4	0.56	Day 4	0.11	Day 4	4.68
Day 5	-6.20	Day 5	-10.14	Day 5	-3.00	Day 5	-8.23
Day 6	4.20	Day 6	3.04	Day 6	3.11	Day 6	4.30

Table 19 displays the market reaction on the COVID-19 pandemic announcement on 12 March 2020. The virus is used to be considered as one of the biggest worldwide disasters causing millions of deaths and leaving long-lasting effects on global health, economies, and social structure. Once the pandemic was announced all the markets experienced significant drops as well as the cryptocurrency market revealing its strong correlation with traditional markets in crises, at the same reacting slightly slower than other markets [74]. On the day of the announcement all the observed cryptocurrencies faced following daily return losses: Bitcoin (-49.73%), Ethereum (-58.96%), Dogecoin (-31.69%) and RIPPLE (XRP) (-42.54%) but already

the next day, all of them slightly recovered their positions. The event itself is obviously considered negative, and it was for the cryptocurrency market when it comes to short term observation. However, only one year after the announcement the price of Bitcoin was estimated at unbelievable \$57265.1 USD against \$4826.0 USD, Ethereum \$1766.9 USD against \$107.9 USD, Dogecoin \$0.055261 USD against \$0.001585 USD and RIPPLE (XRP) \$0.4394 USD against \$0.1360 USD. More than that, the positive trend continued until November 2021, with Bitcoin reaching a price of \$66,904.40 USD. Therefore, it is fair to conclude the following event had a negative impact on cryptocurrencies from a short-term perspective, but from a long-term perspective, it was positive. The cryptocurrency market benefited a lot from the economic uncertainty, institutional adoption, growing demand. Consequently, some of the events and their announcements might have unpredictable future results and it is difficult to measure their impact due to various challenges, psychological factors and uncertainties.

Table 20. Market Behavior and Daily Returns for Cryptocurrencies Following Trump's «Volatile and Baseless» Bitcoin Tweet (11.07.2019, Days -3 to 6)

EVENT		11.07.2019 Tweet: Trump called Bitcoin volatile and baseless. Type: Tweet of an opinion leader							
IMPACT		Negative							
BITCOIN PRICE (USD)		ETHEREUM PRICE (USD)		DOGECOIN PRICE (USD)		RIPPLE (XRP) PRICE (USD)			
Day - 3	12252.6	Day - 3	312.2	Day - 3	0.003466	Day - 3	0.4010		
Day - 2	12541.5	Day - 2	307.4	Day - 2	0.003493	Day - 2	0.3933		
Day - 1	12110.6	Day - 1	289.1	Day - 1	0.003398	Day - 1	0.3614		
Day 0	11342.3	Day 0	268.7	Day 0	0.003244	Day 0	0.3289		
Day 1	11762.1	Day 1	274.7	Day 1	0.003356	Day 1	0.3435		
Day 2	11364.9	Day 2	269.2	Day 2	0.003286	Day 2	0.3321		
Day 3	10200.1	Day 3	226.6	Day 3	0.002963	Day 3	0.3045		
Day 4	10845.9	Day 4	228.5	Day 4	0.003091	Day 4	0.3129		
Day 5	9424.8	Day 5	198.9	Day 5	0.002791	Day 5	0.2953		
Day 6	9723.2	Day 6	211.0	Day 6	0.002898	Day 6	0.3101		
BITCOIN PRICE FORECASTED (USD)		ETHEREUM PRICE FORECASTED (USD)		DOGECOIN PRICE FORECASTED (USD)		RIPPLE (XRP) PRICE FORECASTED (USD)			
Day - 3	11431.9	Day - 3	304.6	Day - 3	0.003641	Day - 3	0.3967		

Day - 2	12251.0	Day - 2	312.7	Day - 2	0.003541	Day - 2	0.4011
Day - 1	12553.5	Day - 1	309.0	Day - 1	0.003555	Day - 1	0.3934
Day 0	12141.5	Day 0	291.9	Day 0	0.003471	Day 0	0.3615
Day 1	11382.3	Day 1	271.9	Day 1	0.003324	Day 1	0.3290
Day 2	11771.8	Day 2	275.5	Day 2	0.003411	Day 2	0.3435
Day 3	11394.9	Day 3	270.8	Day 3	0.003356	Day 3	0.3322
Day 4	10250.3	Day 4	231.6	Day 4	0.003060	Day 4	0.3046
Day 5	10850.1	Day 5	229.9	Day 5	0.003146	Day 5	0.3130
Day 6	9481.0	Day 6	202.7	Day 6	0.002884	Day 6	0.2954
BITCOIN DAILY RETURNS (%)		ETHEREUM DAILY RETURNS (%)		DOGECOIN DAILY RETURNS (%)		RIPPLE (XRP) DAILY RETURNS (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	2.33	Day - 2	-1.56	Day - 2	0.78	Day - 2	-1.94
Day - 1	-3.50	Day - 1	-6.14	Day - 1	-2.76	Day - 1	-8.46
Day 0	-6.55	Day 0	-7.31	Day 0	-4.64	Day 0	-9.42
Day 1	3.63	Day 1	2.19	Day 1	3.39	Day 1	4.34
Day 2	-3.44	Day 2	-2.03	Day 2	-2.11	Day 2	-3.38
Day 3	-10.81	Day 3	-17.20	Day 3	-10.35	Day 3	-8.68
Day 4	6.14	Day 4	0.82	Day 4	4.23	Day 4	2.72
Day 5	-14.04	Day 5	-13.88	Day 5	-10.21	Day 5	-5.79
Day 6	3.12	Day 6	5.90	Day 6	3.76	Day 6	4.89
BITCOIN DAILY RETURNS FORECASTED (%)		ETHEREUM DAILY RETURNS FORECASTED (%)		DOGECOIN DAILY RETURNS FORECASTED (%)		RIPPLE (XRP) DAILY RETURNS FORECASTED (%)	
Day - 3		Day - 3		Day - 3		Day - 3	
Day - 2	6.92	Day - 2	2.62	Day - 2	-2.78	Day - 2	1.10
Day - 1	2.44	Day - 1	-1.19	Day - 1	0.39	Day - 1	-1.94
Day 0	-3.34	Day 0	-5.69	Day 0	-2.39	Day 0	-8.46
Day 1	-6.46	Day 1	-7.10	Day 1	-4.33	Day 1	-9.42
Day 2	3.36	Day 2	1.32	Day 2	2.58	Day 2	4.31
Day 3	-3.25	Day 3	-1.72	Day 3	-1.63	Day 3	-3.34
Day 4	-10.59	Day 4	-15.64	Day 4	-9.23	Day 4	-8.67
Day 5	5.69	Day 5	-0.74	Day 5	2.77	Day 5	2.72
Day 6	-13.49	Day 6	-12.59	Day 6	-8.70	Day 6	-5.79

Table 20 shows the result of a tweet posted on 11 July 2019 by the President of the United States Donald J. Trump. In his post he calls Bitcoin volatile and baseless.

Definitely, such an assessment cannot be considered a positive event for the cryptocurrency. However, not only Bitcoin slightly lost value, but other observed cryptocurrencies also experienced similar declines. Day 0 daily returns for the observed cryptocurrencies look as follow: Bitcoin (-6.55 %), Ethereum (-7.31 %), Dogecoin (-4.64 %), RIPPLE (XRP) (-9.42 %). Forecasted results on the other hand display similar negative numbers for all of them: Bitcoin (-3.34 %), Ethereum (-5.69 %), Dogecoin (-2.39 %), RIPPLE (XRP) (-8.46 %). Consequently, the impact of the announcement might be considered low, and the price drop could be attributed to natural market behavior.

3.3 Results of the Analysis

In the Table 21 the impact of positive events presented based on actual and forecasted cumulative returns covering the selected periods [-3;3], [-4;4] and [-3;6] days. The table mentions the date of the event, the type of it and the currency that was highlighted in the particular announcement.

Table 21. The impact of Positive Events on Cumulative Returns: Actual and Forecasted (Selected Period)

EVENT	27.07.2024 Public speech of an opinion leader. Highlights: Bitcoin			13.07.2023 Regulatory action. Highlights: RIPPLE (XRP)		
TYPE	POSITIVE			POSITIVE		
	ACTUAL Cumulative Returns Around the Event Window (%)			ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	-1.99	1.25	-5.95	-0.09	-0.59	-1.66
ETHEREUM	-7.20	-1.69	-10.34	2.59	2.24	0.44
DOGECOIN	-6.43	-1.92	-12.79	6.84	6.59	7.36
RIPPLE (XRP)	4.28	1.47	-9.30	57.55	56.28	71.51
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	-2.02	1.30	-0.95	-0.17	0.41	-0.98
ETHEREUM	-4.82	-4.76	-7.81	3.09	3.71	1.91
DOGECOIN	-8.85	-1.87	-8.86	6.14	9.51	5.17
RIPPLE (XRP)	3.21	0.82	-0.17	58.77	52.63	66.38

EVENT	28.04.2021 Tweet of an opinion leader. Highlights: Dogecoin			1.04.2021 Tweet of an opinion leader. Highlights: Dogecoin		
TYPE	POSITIVE			POSITIVE		
	ACTUAL Cumulative Returns Around the Event Window (%)			ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	13.01	18.06	9.76	5.79	1.01	-2.89
ETHEREUM	33.14	27.12	41.88	24.88	14.27	7.97
DOGECOIN	37.92	55.57	122.62	11.77	6.10	8.55
RIPPLE (XRP)	48.66	59.67	35.09	67.34	12.29	62.12
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	12.98	14.95	14.04	4.18	2.41	4.04
ETHEREUM	23.61	24.29	51.91	21.03	19.49	24.96
DOGECOIN	53.70	24.39	61.06	5.30	3.88	18.81
RIPPLE (XRP)	41.05	52.05	48.03	15.86	6.08	99.80
EVENT	08.02.2021 Tweet of a company. Highlights: Bitcoin			29.01.2021 Tweet of an opinion leader. Highlights: Bitcoin		
TYPE	POSITIVE			POSITIVE		
	ACTUAL Cumulative Returns Around the Event Window (%)			ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	28.09	25.31	27.01	10.02	3.12	13.78
ETHEREUM	15.50	3.91	4.80	14.68	0.52	16.67
DOGECOIN	31.82	48.80	33.89	274.67	321.18	542.52
RIPPLE (XRP)	37.05	16.91	31.14	39.13	38.45	65.54
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	27.44	21.29	27.49	3.93	2.75	16.54
ETHEREUM	8.04	9.09	13.65	-0.58	-0.35	24.69
DOGECOIN	89.89	41.03	29.73	298.41	328.43	335.86
RIPPLE (XRP)	32.95	13.59	42.47	36.04	84.87	48.41
EVENT	20.12.2020 Tweet of an opinion leader. Highlights: Dogecoin					
TYPE	POSITIVE					

	ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	11.17	1.89	15.90
ETHEREUM	-3.93	-8.94	-1.02
DOGECOIN	33.60	1.18	21.09
RIPPLE (XRP)	-40.86	-54.94	-49.02
	FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	19.75	11.69	15.77
ETHEREUM	0.22	0.30	-1.21
DOGECOIN	19.51	32.81	33.36
RIPPLE (XRP)	-44.28	-21.66	-44.27

Analyzing the results displayed in the Table 21 it can be concluded that the impact of positive announcements has a fading tendency year by year at the same time high volatile cryptocurrencies tend to react on positive announcement longer offering higher returns. The analysis shows that it gets more and more difficult to influence stable (that have moderate level of volatility) currencies such as Bitcoin and Ethereum nowadays especially with public announcements that don't imply any actions in the nearest future. Donald Trump's speech on 27 July 2024 can be a good example of it. Such announcements these days have rather a short duration of effect – a few hours significantly affecting the price multiple times during the trading day then getting fixed and stabilized by the market itself. The impact of them might also be displayed later when the action starts to take place. Constantly growing number of crypto asset users might be one of the key factors of the market stabilization (Figure 22). The number of owners of cryptoassets got 6 times bigger than it was when Elon Musk started publishing his Dogecoin related tweets in 2019. As well as the price of cryptoassets significantly increased making it more attractive for qualified investors that are rather reasonable than emotionally driven at least when it comes to stable currencies (Bitcoin, Ethereum).

Number Of Identity-Verified Cryptoasset Users From 2016 To June 2024

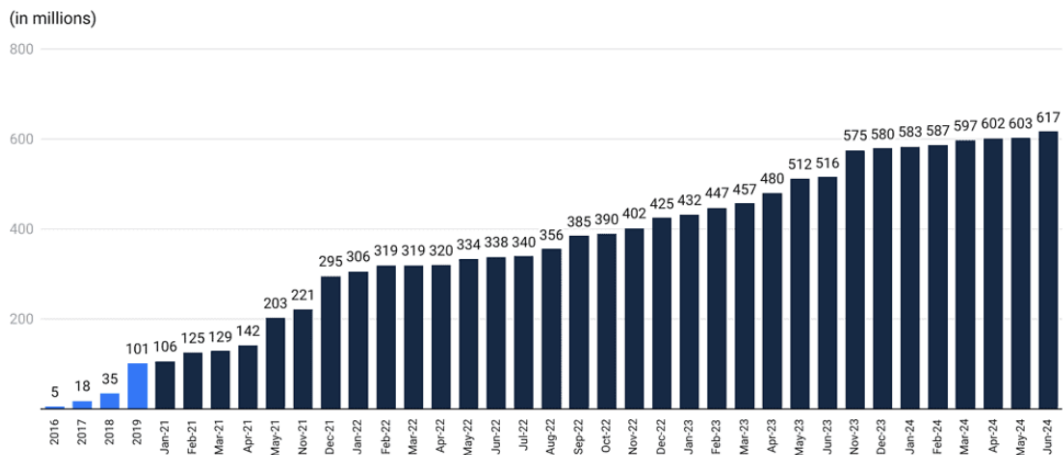


Figure 22. Number of Identity – Verified Cryptoassets Users from 2016 to June 2024

Source: [75].

Significant price changes of small and volatile currencies (Dogecoin, RIPPLe(XRP)) can be explained by their cheapness as well. Dogecoin is considered a meme coin, and investors can potentially buy it even for fun, especially when someone known promotes it increasing the interest. Dogecoin's bubble effect is visible based on the fact it was the only coin from all the observed ones to hit more than 100%, and once more than stunning 500%, of cumulative returns around the event window [-3;6] during three out of seven positive events observed making it the most manipulated cryptocurrency from all the observed ones. It also proves its extremely high volatility status. RIPPLe(XRP) is also a high volatile currency, however, it is designed as a digital payment network that focuses on providing fast, low-cost, and scalable solutions for cross-border transactions, at the same time is also rather extremely cheap compared to Bitcoin. Probably, with this low price and high volatility understanding it investors buy a small amount of those currencies diversifying the risk and giving the priority to the stable currencies not being afraid to lose a lot from fluctuations of the small ones. As well, available platforms such as Binance, for example, attract with their user-friendly interface and the ease of getting started with trading unqualified investors who buy cheap cryptocurrencies as a long-term investment expecting it to repeat Bitcoin's success. These people might even be skeptical about Bitcoin and scared of its value, however still curious about the new opportunities the cryptocurrency market offers. In fact, curiosity is the key driver behind all the

cryptoassets but especially behind the small ones as it is easy to calculate (it is only possible to buy a very small part of Bitcoin for \$1 USD but it is possible to buy even more than 1 Dogecoin), easy to buy and easy to sell using the available platforms, so unqualified investors could be joining the market buying them once there is a new announcement published. The correlation between the observed currencies is also visible, however Tables 21-23 display cumulative returns around the event window and other factors could occur during this period of time affecting one or another cryptocurrency. The forecasted values displayed in the Tables 21 – 23 indicate similar values meaning the model is able to predict the general price movement and trend quite accurately.

Negative events such as the Black swans and their impact observed in the Table 22, in fact only had a negative impact on cryptocurrencies for a certain period of time.

Table 22. The impact of Negative Events (Black Swans) on Cryptocurrencies: Short-Term Effects

EVENT	24.02.2022 Black swan. Affection: ALL			12.03.2020 Black swan. Affection: ALL		
TYPE	NEGATIVE / POSITIVE			NEGATIVE / POSITIVE		
	ACTUAL Cumulative Returns Around the Event Window (%)			ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	12.60	1.81	18.63	-37.39	-32.35	-32.42
ETHEREUM	11.57	1.81	14.68	-44.26	-38.70	-41.94
DOGECOIN	-2.30	-4.00	3.86	-24.84	-23.72	-24.75
RIPPLE (XRP)	0.73	2.82	9.58	-30.86	-26.96	-29.63
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	-5.89	1.87	15.58	-39.63	-35.46	-34.68
ETHEREUM	-4.91	5.42	12.79	-47.51	-38.76	-42.64
DOGECOIN	-12.26	-6.89	-2.35	-29.07	-22.46	-22.29
RIPPLE (XRP)	-12.18	-3.25	1.06	-35.21	-28.35	-27.81

The results of two different Black swans were observed in the Table 22 that had a, more or less, significant impact on the global markets. The behavior of markets is difficult to predict reacting on the Black swans, as such events significantly affect even stable markets. However, in case of cryptocurrencies it is fair to assume that the ultimately fast recovering effect after the one that occurred on 24 February 2022 could be the result of the previous one happened on 12 March 2020. Russo – Ukrainian conflict resulted sanctions undermining trust in the global financial system therefore qualified investors and the ones who wanted to save their assets decided to invest in stable cryptocurrencies such as Bitcoin and Ethereum not really being interested in volatile ones like Dogecoin, Ripple(XRP) could still be interesting as it was designed as an alternative to traditional payment systems like SWIFT that was canceling transactions . However, volatile ones during the starting dates of pandemic lost almost two times less than the holders of stable ones, presumably due to the cheapness of small ones and assuming that many were buying small number of coins not being afraid to lose. At the same time stable currency holders were rather at risk to lose a lot due to the value of their assets. According to the figure 22 in 2020 there were approx. 100 million crypto asset users, so the market could easily be influenced by panic, at the same time in 2022 there were already three times more crypto asset users registered, consequently the market got more stable. More than that some investors could be the ones who remembered the long-term positive impact of the other Black swan observed – COVID 19 pandemic that started with a free fall across all the markets. Therefore, it is reasonable to conclude that, at present, Black Swan events of global significance are beneficial for the cryptocurrency markets.

Table 23 indicates the events with the clear negative impact on the cryptocurrency market.

Table 23. Events with Clear Negative Impact on the Cryptocurrency Market

EVENT	07.11.2022 Bankruptcy of a cryptocurrency exchange FTX. Affecting: Every currency observed	12.05.2021 Tweet of an opinion leader. Highlights: Bitcoin
TYPE	NEGATIVE	NEGATIVE
	ACTUAL Cumulative Returns Around the Event Window (%)	ACTUAL Cumulative Returns Around the Event Window (%)

	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	-15.62	-16.82	-22.80	-21.10	-19.80	-26.34
ETHEREUM	-15.84	-21.02	-25.75	-8.28	-7.15	-13.89
DOGECOIN	-30.45	-28.85	-32.60	-19.13	-10.77	-16.52
RIPPLE (XRP)	-15.52	-22.00	-32.65	-7.21	-3.17	3.65
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	-12.96	-21.01	-16.83	-18.36	-15.24	-25.82
ETHEREUM	-15.77	-26.60	-17.72	5.59	4.57	-14.52
DOGECOIN	-31.53	-38.31	-28.61	-24.37	-13.65	-23.43
RIPPLE (XRP)	-12.29	-26.99	-20.11	-6.02	-10.18	-4.26
EVENT	22.12.2020 Regulatory action. Highlights: RIPPLE (XRP)			11.07.2019 Tweet of an opinion leader. Highlights: Bitcoin		
TYPE	NEGATIVE			NEGATIVE		
	ACTUAL Cumulative Returns Around the Event Window (%)			ACTUAL Cumulative Returns Around the Event Window (%)		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	14.38	3.55	13.48	-4.99	-16.75	-20.64
ETHEREUM	-2.64	-4.75	10.92	-25.06	-27.42	-32.44
DOGECOIN	16.70	16.25	17.04	-13.66	-14.51	-16.39
RIPPLE (XRP)	-49.51	-44.81	-56.76	-21.10	-24.06	-22.67
	FORECASTED Cumulative Returns Around the Event Window			FORECASTED Cumulative Returns Around the Event Window		
	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days	[- 4; 4] Days	[-3;3] Days	[-3; 6] Days
BITCOIN	8.24	2.62	13.60	-9.13	-0.32	-17.07
ETHEREUM	-2.61	-6.50	4.07	-19.92	-11.10	-33.45
DOGECOIN	23.06	16.73	17.85	-15.28	-7.83	-20.79
RIPPLE (XRP)	-44.93	-42.12	-51.34	-21.96	-16.26	-25.54

The clear negative events have a more significant impact on cryptocurrencies meaning that the recovery period might take longer than the effect of positive announcements. Negative announcements affecting Bitcoin usually automatically

affect other ones as well (the ones it correlates with the most), however the numbers remain negative for longer due to the lack of trust. The market keeps rapidly growing but remains uncertain. Everyone knows - nothing backs the cryptoassets, and no one has ever seen the cryptocurrency market collapsing for real. Back when the number of users was smaller, it was easier to influence the market with tweets. However, nowadays, the market has become more stable, and only significant negative events can cause investors to panic. For example, a tweet posted on 11 July 2019 by the President of the United States Donald J. Trump where he calls Bitcoin volatile and baseless had a similar impact on the market with a bankruptcy of a cryptocurrency exchange FTX started on 7 November 2022. The difference between the number of worldwide crypto asset users is approx. 200 million (Figure 22). The first event involves an online post, while the second is a real collapse of a cryptocurrency exchange that caused users to urgently attempt to withdraw their funds from the platform undermining trust in other platforms as well. Regulatory action against Ripple (XRP), as shown in Table 23, had an impact primarily on Ripple itself. The currency showed the least correlation with the other three, and the positive movement in the others could be explained by investors choosing to reinvest their assets in more stable currencies, along with the less stable Dogecoin. The announcement on 12 May 2021, was a significant one, as Tesla, led by Elon Musk, made the impactful decision to stop accepting Bitcoin as payment for its vehicles, despite having invested \$1.5 billion in Bitcoin earlier that year. Certainly, Bitcoin, along with Ethereum, reacted to this, as did Dogecoin, given that Elon Musk is seen as its ambassador, at the same time Ripple (XRP) remained stable.

The results of the research align with several key findings from the existing literature. One notable similarity is the observation that the impact of positive announcements tends to fade over time, especially for stable cryptocurrencies like Bitcoin and Ethereum. This finding resonates with the work of Lyócsá et al., who emphasized that the volatility of Bitcoin is strongly influenced by regulatory announcements but diminishes as time progresses. Similarly, Mužić and Gržeta's study found that macroeconomic news significantly affects Bitcoin's returns, but its impact on volatility or trading volume remains limited, suggesting that the market stabilizes over time in response to such news.

Additionally, the research indicates that smaller, more volatile cryptocurrencies like Dogecoin and XRP tend to react more strongly to announcements, which echoes findings from Hashemi Joo et al., who reported that abnormal returns, particularly in response to negative news, can be observed for several days after an event. This aligns with Öget's study, which found that negative events had a stronger impact on cryptocurrencies than positive news, reinforcing the view that volatile cryptocurrencies are more susceptible to swings based on sentiment-driven events.

The observed slower absorption of information by the market, with effects extending for several days after announcements, is also consistent with the findings of Hashemi Joo and others. Their research suggested that market reactions can persist long after the initial event, with negative news having more prolonged effects compared to positive events. This is further reflected in the behavior of the cryptocurrency market in response to public announcements, as noted by Gunay, who found that public information, such as Twitter posts, has a delayed effect in both bull and bear markets.

Moreover, the research corroborates the literature regarding the relationship between the number of cryptocurrency users and market stabilization. As the market grew, it became more resistant to fluctuations driven by announcements, a conclusion also supported by the findings of Makarov and Schoar, who identified factors like market segmentation and regulatory oversight as influential in price formation and arbitrage behavior. This shift toward greater market stability is also in line with the studies by Corbet et al., who found that more mature assets like Bitcoin exhibit less volatility in response to regulatory news, similar to the results observed for Bitcoin and Ethereum in the present research.

However, the research also departs from some existing studies in its conclusion that Black Swan events, such as the COVID-19 pandemic and the Russo-Ukrainian conflict, have had a more positive impact on the cryptocurrency market than anticipated. This finding contrasts with the more typical view of Black Swan events as leading to market turmoil, as seen in the literature, including the work of Mrestyal and Maaz Khan, who highlighted the clustering of volatility in the wake of the COVID-19 pandemic. Nevertheless, the rapid recovery observed in the cryptocurrency market

following these events supports the notion that the market has become more resilient over time, potentially due to the increasing involvement of institutional investors and the market's growing maturity, as also noted by Park and Chain, who highlighted the role of information asymmetry and sentiment in driving market behavior.

Finally, while most of the findings align with previous research, the study's conclusion regarding the impact of tweets and social media posts, especially in the case of Dogecoin, extends some of the ideas put forward by Bakhtiar et al., who emphasized the influence of social media sentiment on cryptocurrency prices. This effect, particularly for meme coins, is less clearly established in the existing literature, but the present research highlights its importance in shaping short-term market movements. The research supports the view that speculative behavior, driven by high volatility and low prices, plays a significant role in price fluctuations for smaller cryptocurrencies, a phenomenon that may be amplified by social media endorsements or endorsements from influential figures.

3.4 Practical Implications

Considering the results of the study it is fair to recommend to the potential investors despite the announcements being positive or negative to be cautious, as for now, it is still impossible to prove if the cryptocurrencies are a fraud or it is a good alternative for national currencies. There is also plenty of «failed» cryptocurrencies, so it is essential to double check and to think twice before buying such rather unknown coins. However, the market gets more and more stable by attracting more and more new cryptocurrency users. By buying a company's stocks, an investor also risks losing the money they invested. Cryptocurrency market, as for now, can be also considered a positively trending somehow stable and even offers some moderate level volatility cryptocurrencies (Bitcoin, Ethereum) along with extremely high-level volatile ones such as Dogecoin, Ripple (XRP) for example. Consequently, it is advisable to diversify the assets in the portfolio giving the priority to less volatile coins and to well-known high-level volatile ones.

It is also crucial to select the right broker—a trading platform and wallets as well—since they require personal data, and there is a risk of the platform collapsing or imposing sanctions that could restrict the withdrawal or transfer of funds.

According to the results of the analysis it is also advisable to buy cryptoassets once the black swans appeared as during the economic, political, social, geopolitical, technological instability. Such advice is still considered extremely risky due to the limited number of observed Black Swan events within the relatively short period of cryptocurrencies existence.

Considering the longer reaction on negative events and overall positive trends of all the observed cryptocurrencies it could be advisable to buy not right after the negative announcement was made but a few days after.

Similarly to the stock market it is important to find an own strategy – for example long-term holding fewer volatile currencies through market fluctuations could be beneficial considering overall positive trends and the potential growth over time.

To develop the concept of cryptocurrencies it is recommended to use forward contract that is a financial agreement between two parties to buy or sell an asset such as currency, commodity or financial instrument at a predetermined price on a specific future date – such a contract could minimize the risks of fluctuations and therefore making cryptos more like real currencies rather than stocks.

CONCLUSION

In this study, the history of well-known markets was observed, as the cryptocurrency market is still a market and is formed in a similar manner to existing ones. The history of cryptocurrencies shows that the concept is much older than Bitcoin; however, it wasn't until Bitcoin that it gained widespread popularity. The core idea of cryptocurrency—anonymity—is gradually fading, as more and more online platforms and wallets require users to register with IDs or other documents that verify their identity. As a result, cryptocurrency transactions are becoming less distinguishable from transactions involving traditional currencies. However, fast transactions and anonymity perhaps not the key reasons of Bitcoin's success. The idea of offering economic incentives in the form of actual coins to participants in a blockchain system existed before Bitcoin, but Bitcoin was the first to implement it. As a result, its success may have been largely influenced by this feature. At the same time dealing with cryptocurrencies might cause legal problems as they are considered illegal in many countries, so investors always must keep an eye on the legislation and its changes. As well as if it was stolen by someone from investor's account it might not be considered as a crime as the legal status of cryptoassets remains unknown in some geographies where they are not considered as property due to not having material equivalent. Along with risks other markets have too, cryptocurrency market has also unique ones, for example: only cryptoassets have no real assets behind them. Many cryptocurrencies have already failed (more than 8000 cryptocurrencies have failed only in 2021 and 2022 combined) and many of them were considered fraudulent. At the same time national currencies that are no longer in use are typically replaced, with central banks offering holders an alternative currency, so there is still an advantage of having a central authority.

Additionally, there is another risk there might be another coming up in the nearest future – AI (Artificial Intelligence), that can potentially guess passwords to get the access to online wallets with cryptocurrencies. The amount of risks compensates with the offered profit. So even banks deal with cryptocurrencies to generate profit and even fail like Silvergate bank that recently faced bankruptcy.

Taking into account the above-mentioned facts, the purpose of this study was to analyze the influence of announcements and significant events on the price

movements of Bitcoin, Ethereum, Ripple, and Dogecoin. The research aimed to identify patterns in market reactions, assess the volatility and stability of these cryptocurrencies, and evaluate the impact of public announcements, regulatory actions, and major events on market sentiment. The historical exchange rate secondary data sourced from Investing.com was used that covers the period from 03 June 2017 to 27 October 2024, for all the selected cryptocurrencies. And includes more than 2700 daily price observations. This period encompasses major and minor announcements collected from the following sources: BBC News, CNN, Reuters, The New York Times, The Wall Street Journal, Forbes, Bloomberg, The Financial Times and Twitter (now X) itself. The methodology of the study starts with the data collection and its observation process, then classic statistical methods application such as correlation analysis, graph plotting and observation, daily returns and cumulative daily returns calculations along with trending analysis. The analysis shows that the cryptocurrency market keeps getting more and more stable due to constantly increasing the number of users. Moreover, the market has a strong positive trend, so all the observed currencies are expected to increase in price over time (not considering future unexpected events). Similarly to the foreign exchange market there are less volatile and more volatile ones. In terms of volatility the currencies observed in the study such as: Bitcoin, Ethereum show moderate level of volatility and Dogecoin, Ripple (XRP) show high level of volatility. In terms of correlation not every cryptocurrency out of the observed ones has a strong correlation with Bitcoin as for example the level of correlation between Bitcoin and Ripple is moderate and it is even stronger between Dogecoin and Ripple (XRP) (0.62) than between Bitcoin and Ripple (XRP) (0.49). The strongest correlations are between Bitcoin and Ethereum (0.93) and those are considered the less volatile ones and between Dogecoin and Ethereum (0.84), due to the following coefficients there could be some multicollinearity between them as well. Based on that it is possible to influence one coin to manipulate the other as they tend to grow or fall together and therefore to profit from a smaller, correlated currency.

The results display the fading impact of announcements on the cryptocurrencies due to the stabilizing type of a market (rapidly growing market with more than 600 million users). It gets more and more difficult to influence stable (moderate level volatility coins such as Bitcoin, Ethereum) and no matter if the

announcement is positive or negative especially with the ones that don't imply any action. Negative announcements tend to have longer effect than positive ones, at the same time, it is fair to notice the lack of negative posts (comments) from the opinion leaders towards cryptocurrencies like it was years ago. Consequently, it is fair to assume opinion leaders somehow manipulate the market with only positive posts of bullish expectations as they are also cryptocurrency users and have their money invested. The effect of the positive or even negative ones can remain visible only within one trading day and to barely affect closing prices. The effect might appear later; however, it might be impossible to forecast when exactly and if it will in general. For example, the results indicate that Black Swan events of global significance are beneficial for the cryptocurrency markets (long-term) as investors prefer cryptocurrency during the economic, political, social, geopolitical, technological instability.

High level volatility coins such as Dogecoin and Ripple (XRP) used to get easily manipulated by the announcements drastically reacting on them, however due to their cheapness investors can potentially buy them even for fun (Dogecoin was designed as a meme for example), especially when someone known promotes it increasing the interest. Therefore, with this low price and high volatility understanding it investors buy a small amount of those currencies diversifying the risk and giving the priority to the stable currencies not being afraid to lose a lot from fluctuations of the small ones. As well, available platforms such as Binance, for example, attract with their user-friendly interface and the ease of getting started with trading unqualified investors who buy cheap cryptocurrencies as a long-term investment expecting it to repeat Bitcoin's success. These people might even be skeptical about Bitcoin and scared of its value, however still curious about the new opportunities the cryptocurrency market offers. In fact, curiosity is the key driver behind all the cryptoassets but especially behind the small ones as it is easy to calculate (it is only possible to buy a very small part of Bitcoin for \$1 USD but it is possible to buy even more than 1 Dogecoin), easy to buy and easy to sell using the available platforms, so unqualified investors could be joining the market buying them once there is a new announcement published and keeping them as well in case it is bad.

The market continues to grow rapidly but remains uncertain, as no one has ever seen it collapse therefore no one knows how it is going to react once it starts losing the trust of its users and how fast it will be plus everyone knows - nothing backs the cryptoassets. Back when the number of users was smaller, it was easier to influence the market with tweets. However, nowadays, the market has become more stable, and only significant negative events (for example a collapse of a cryptocurrency exchange) can cause investors to panic.

The strengths of this study lie in its comprehensive analysis of the cryptocurrency market, drawing on over 2700 daily price observations from 2017 to 2024 to offer a data-rich and robust examination. By including a variety of cryptocurrencies—Bitcoin, Ethereum, Ripple (XRP), and Dogecoin—it provides a nuanced understanding of market volatility and investor behavior across different assets. The study employs solid statistical methods such as correlation analysis and returns calculations, while focusing on real-world events like regulatory actions and public statements from opinion leaders, making it highly relevant to market participants. It also explores the evolving stability of the cryptocurrency market, noting how external factors, such as Black Swan events, influence investor sentiment and market dynamics. Additionally, the research delves into the growing influence of social dynamics and investor curiosity, especially regarding low-priced, high-volatility coins like Dogecoin, offering valuable insights into the behavioral aspects of the market. Finally, by addressing potential future risks such as AI-driven security threats, the study provides a forward-looking perspective on the challenges and opportunities in the cryptocurrency space.

This study has several limitations, including its reliance on historical price data, which may not fully reflect future market shifts, and its focus on only a few major cryptocurrencies, excluding emerging assets. The impact of social media sentiment and real-time regulatory changes is also underexplored. Future research could broaden the scope by including a wider range of cryptocurrencies, examining the influence of newer social media platforms, and investigating the effects of global regulatory trends and technological advancements like AI and blockchain on market behavior and stability.

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