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INVESTIGATING AN INDIVIDUAL'S OPINION ON SOCIAL MEDIA ABOUT THE CRYPTOCURRENCY MARKET

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Abstract. Cryptocurrencies are growing rapidly, with various altcoin being introduced recently, despite the fact that the market is very volatile, cryptocurrency now holds trillions of dollars in the market and has plenty of platforms for trading and owning cryptocurrencies, like Binance, Coinbase, and others. In particular, Bitcoin has caught the attention of many people over the year with a current market cap. of 731.56 billion dollars circulating in the market. One of the major problems in cryptocurrencies is volatility, and often the prices can vary due to the external events that trigger the market. That is, Twitter sentiment. The objective of the article is to investigate people's opinion about the cryptocurrency market on social media using collected tweets for 2 popular hashtags of Bitcoin and investigating the tweets using sentiment analysis. The study found that sentiment scores could be related to observed price fluctuations.

Keywords: sentiment analysis, cryptocurrencies, textual analysis, tweet sentiment score, cryptocurrency market, VADER model.

JEL Classification: G40, G15.

Introduction

In recent years, developers, investors, and others have gained interested in cryptocurrency, since it is an emerging technology and rapidly growing investment business model when we compare it with other investment opportunities. However, the market is highly volatile (Hassani et al., 2018). Cryptocurrency is currently holding trillions of dollars in the market with the gained popularities over the years. Currently, there are many platforms available for trading or owning cryptocurrencies such as Binance, Coinbase, etc. The Bitcoin cryptocurrency has become very popular in the cryptocurrency market among multiple other currencies. Currently, Bitcoin is holding cap. of 731.56 billion dollars circulating in the market (Yahoo Finance, n.d.) Cryptocurrencies enable decentralized peer-to-peer network or online transactions to be carried out by "miners" inside a trade network. Therefore, the cryptocurrency network is not controllable by a centralized authority or any third-party financial institutions. All cryptocurrencies network transactions are recorded in blocks on the open ledger known as the blockchain, which are validate by miners using cryptographic proof-of-work (Muhammad Fahmi et al., 2018) Digitalization and technological advancement helps to gather and analyze cryptocurrency data to predict future market trends. Therefore, Big data technologies have increased demand for roles and management in the world of cryptocurrencies (Hwang & Chen, n.d.) Big data analytics helps identify trading signals in the cryptocurrency market. Furthermore, cryptocurrency platforms cause no latency for the traders to engage in live trading, and it also satisfies the five key features of big data (velocity, volume, veracity, value, and variety) (Banco Bilbao Argentaria, n.d.). However, there are still opportunities in the cryptocurrency market to apply big data models. This research aims to understand people's opinion about the cryptocurrency market on social media using tweets collected and investigating the tweets to find if there are any price fluctuation when the sentiment scores were allocated to the chosen cryptocurrency price. To achieve the results, the paper was divided into 3 main parts, Firstly, investigation of theoretical background of cryptocurrencies, factors affecting cryptocurrencies price along with the theoretical background on the influence of social networks on an individual's decision was carried out. Secondly, the right methodology was chosen for

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applying the pre-processed data and thirdly, the chosen models (VADER) was applied to achieve the results.

1. Theoretical aspect of the cryptocurrency market

Money has evolved in several ways, from commodity money to today's digital currency. A cryptocurrency is a digital asset or digital money that was introduced by a person or persons named Satoshi Nakomoto in 2008. The Genesis Block (name introduced for the first block of the cryptocurrency) which mined (the process of verifying and adding the transactions to the blockchain) in 2009, that was the first Bitcoin block. On 9 January of that year, the initial version of the Bitcoin software was published. On 12 January, the first bitcoin trade took place when Nakamoto transferred 10 bitcoins (BTC) to well-known computer programmer and entrepreneur Hal Finney (The Street, n.d.) It uses encryption to protect transactions, to track the generation of new units, and to verify asset transfers. Most cryptocurrencies are built on decentralized networks known as blockchain technology. That is, a distributed ledger enforced by the network's nodes (servers/computers) and preserve the history of each transaction. It cannot be changed or altered later. Therefore, it is considered a secure transaction compared to the existing transaction methods (Aggarwal & Kumar, 2021). Bitcoin is the first decentralized cryptocurrency, and later numerous cryptocurrencies have been developed and introduced to the market. There are many alternative coins that exist that are known as altcoins. The fundamental component in the Bitcoin invention was the adoption of a distributed processing method known as the "Proof-Of-Work" algorithm (Muhammad Fahmi et al., 2018). To own Bitcoin or altcoin, an individual must first download a Bitcoin wallet. It is software that allows one to receive, store, and transmit Bitcoin units in fractions. The next stage is to swap the fiat currency (government-issued currencies) for Bitcoin units such as the US dollar. The account holder can then use the fund to purchase Bitcoin units or many other crypto assets (Berentsen & Schär, 2018). The sentiments of tweets are considered one of the factor in the volatility of cryptocurrency. Stock and FX markets are heavily influenced by economic indicators such as major economic events, government news, etc. Each cryptocurrency has its own set of events that are more particular to that cryptocurrency and might affect its price. The "coins calendar" is a calendar of cryptocurrency events that can schedule cryptocurrencies events and be used as a cryptocurrency trading or investment guide. Comparable to an economic calendar for the FX and stock markets. Table 1 describes the top 10 cryptocurrencies according to their market capitalization in 2021.

Table 1. Top 10 cryptocurrencies according to market capitalization (source: made by the author based on coinbase live data)

Name	Current price (in eur)	Market Cap. (in eur)
Bitcoin (BTC)	37.436	704.8B
Ethereum (ETH)	2.630	309B
Cardano (ADA)	1.83	59.1B
Tether (USDT)	0.85	58.2B
Binance Coin (BNB)	318.96	53.7B
Ripple (XRP)	0.80	37.6B
Solana (SOL)	123	36.7B
USD coin	0.85	25B
PolkaDot (DOT)	25.21	25B
Doge (DOGE)	0.18	24B

This research will be limited to Bitcoin only. However, for future work, the top 6 cryptocurrencies will be considered.

1.1. Factors influencing cryptocurrency price

The volatility behaviour of the cryptocurrency market has major impacts on price movement. Below are a few factors that play a role in the price fluctuation.

Cryptocurrency mining: Mining is one of the key activities that affects the value of a cryptocurrency. Due to the technological advancement in the block chain, crypto mining has become members to submit a new batch of transactions to the decentralized database; incentives are given in exchange. In fact, players use their computer power to solve difficult riddles. The first individual who solves the puzzle can add a block of new transactions to the chain of current transactions. As a result, the computer sends the new block to the network, allowing all participants to update their own copies of the blockchain. The answer is straightforward to verify, despite the difficulty of the puzzle. The competition for the privilege of adding a block to the blockchain addressed the challenge of producing new electronic currencies. People who respond to the challenge can earn a mix of newly issued currency and transaction fees. As a result, new coins will be produced with each block. Every four years, the quantity of new coins per block is lowered by half, until the maximum of 21 million Bitcoins is achieved. Several of the remaining bitcoins will be added in the next 15 years. Investors have created huge computer resources with sophisticated processors to fight for approval to add blocks to the blockchain in the mining process, lured by the incentive of newly produced digital currencies. Over the previous years, the prizes for solving the problem have fluctuated from $100,000 to $250,000, depending on the cryptocurrency's price, processing costs, and the number of transactions in a block. As additional computer power was added to the network, the problem became increasingly challenging (Figure 1). As a result, more and more power is required to solve these riddles. According to the investigation, a mining network uses around 53 TWh of energy per year, which is equal to Bangladesh's total annual energy usage (Digiconomist, n.d.). The cost of energy needed to execute a single

typical transaction in a developed nation is around $20, which would be the power consumption of five families per day (European Parliament, 2018).

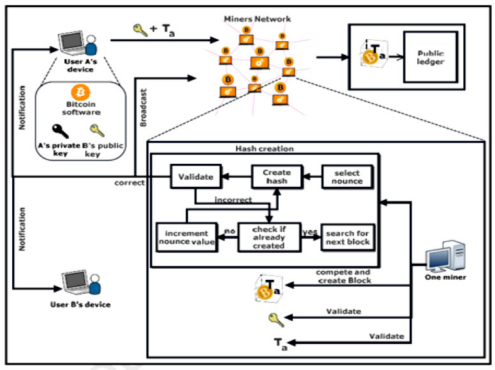

Figure 1. Blockchain technology (source: Ghosh et al., 2020)

The picture above describes the architecture of blockchain technology. For example, according to the above picture, Sender A must have Bitcoin activated on his or her computer to transmit a few bitcoins to recipient B. The use of lightweight client-side software has become more popular as an alternative to full Bitcoin software. The sender's private key, as well as the recipient's Bitcoin address, are required. The transfer of digital assets to the sender's Bitcoin address is available to anyone on the blockchain network. However, only an individual signature created with the use of a private key can authorise the transfer of bitcoins from an account.

SP500 index: According to a recent study, The SP500 index appears to have a mild positive long-term influence on Bitcoin, Ethereum, and Litcoin, but its sign shifts to negative losing significance in the short run, except for Bitcoin, which provides an estimate of –0.20 at a 10% significance level (Sovbetov, 2018).

Attractiveness: It has been identified in many research, that the popularity of cryptocurrencies also plays an important role in determining their price, but only in the long run (Sana Guizani, 2019; Sovbetov, 2018). For example, according to figure 2 in the year of 2020, the number of Bitcoin in circulation went from 12.3 million to 18.59 million and price went from 10.86 $ to 47 712.70 $ within just 8 years.

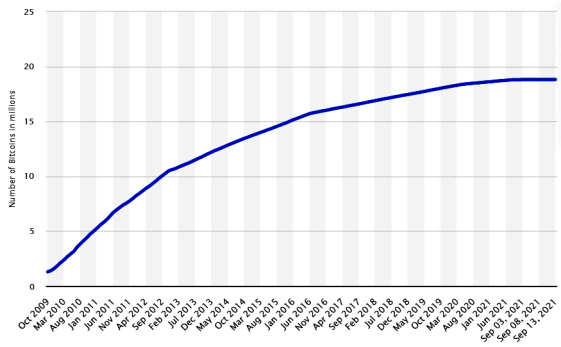

Figure 2. Number of Bitcoins in circulation worldwide from October 2009 to September 13, 2021 (source: Statista, n.d.)

Celebrity/government effect: Celebrities have a great power to influence one's thought. Celebrity opinions and/or thoughts can influence followers' perceptions of cryptocurrency. Their supporters embrace anything they say whether it is correct or incorrect (Aggarwal et al., 2019). For example, Elon Musk (CEO of Tesla motors) and Mark Cuban (American Entrepreneur) tweets have resulted in the dogecoin price to increase by 20%. (CNBC, n.d.) Similarly, bank notices, such as banning, regarding cryptocurrency can also have an influence on public opinion, which might influence the price overall. Recently the China government for instance declared all cryptocurrency transactions illegal, which resulted in a drop of bitcoin price by $2000 (BBC News, n.d.).

Cryptocurrency planned events: Coins Calendar is a calendar of cryptocurrency events. To put it another way, it is a calendar of all the bitcoin events that are scheduled. Coin Calendar is a cryptocurrency trading and investment guide, comparable to an economic calendar for FX and stock markets. A cryptocurrency calendar is a website that contains data such as:

- Predicted percentage of impact;
- The date on which the event will be released;
- The reason for the anticipated impact.

1.2. Big data in the cryptocurrency market

Energy inefficiency, computational scalability, market entry hurdles, and regulatory problems are just a few of the drawbacks of cryptocurrencies that could be addressed with Big Data analytics (Hassani et al., 2018). The combination of big data and blockchain technology offers many companies the opportunity to develop while also strengthening the cryptocurrency industry. Big data can already reveal patterns and trends that can lead to valuable business insights. When used to examine cryptocurrencies, data analytics can be a valuable tool to anticipate trends and avoid illicit behaviours. Big data tools can also be used to build models or trading signals that will help traders monitor the sudden spike in hashtags on social networks during a given period of time. Using big data tools, some investigations have been conducted to analyze tweet volume in the cryptocurrency market, for example, Stenqvist and Lönnö (2017) created a model to anticipate BTC price changes based on Twitter posts over a 31-day period, collecting 2271815 tweets and evaluating them using the VADER lexicon approach. The BTC/USD price was then compared with the compound sentiment scores with a threshold of 0.5 using time series with intervals ranging from 5 minutes to 4 hours. According to the research, the data can accurately forecast price development directions by up to 83%. Big data technologies enable us to assess the feasibility of utilizing unstructured data from social media sites to make Bitcoin price forecasts based on sentiment analysis. Also, using a service like Google's Big Query to measure the number of people who search a certain phrase each day is one of the easiest (and cheapest) ways to leverage Big Data. This is a free service that uses a structured query language (SQL)

interface to allow users to query terabytes of data in seconds. (SQL is a computer language created specifically for handling data in relational database management systems) (Pence, 2014).

1.3. Theoretical aspect of the influence of social networks on an individual's decision

In recent years, social networks have grown in popularity due to the inherent and ongoing human urge for interaction, as well as the simplicity with which these virtual relationships may be created and maintained. Exploiting social media data has been done in many research and language processing operations, since social networks communities now provide a huge supply of knowledge and opinions on every issue. According to previous research, social media influences decision-making by increasing the number of connections available to acquire information and opinions. People are more likely to trust the opinions of other members of online communities in which they have decided to join (Power et al., 2011) and especially, Twitter has become one of the major people influencing platforms in recent years which also has some impact on financial market. According to another research, it was discussed that investors' reactions are influenced by information released on Twitter, which has a positive or negative impact on stock indexes, as well as upward or downward trends. Low risk tolerance is the result of negative emotions (Valle-Cruz et al., 2021). There have been many researches carried out to find the correlation between tweets and cryptocurrency price movement after cryptocurrencies emerged mainly due to the fact that the cryptocurrency market is highly volatile and is not centralized and is heavily influenced by external factors. According to Kraaijeveld and de Smedt (2020) it was discovered that Twitter sentiment has predictive potential for the returns of Bitcoin, Bitcoin Cash, and Litecoin using a cryptocurrency-specific lexicon-based sentiment analysis technique, financial data, and bilateral Granger-causality testing. The predictive power for EOS and TRON is discovered using a bullishness ratio. One thing to keep in mind is that such an impact can have a negative and positive return on the investment.

2. Methodology of cryptocurrency market investigation

In this section, all the methods used in the research will be explained. The main methods used for the research are textual analysis and sentiment analysis. The VADER sentiment model has been chosen as the best fit to assign scores (–1 to +1) to the collected data and to analyze whether the tweet is "positive" or "negative". Textual data has been chosen for the research to identify the emotion and opinion of people. Figure 3 is a wider illustration of the methodology used.

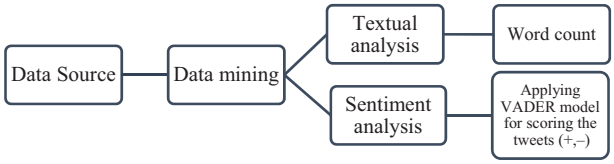

Figure 3. Scheme of investigation (source: compiled by the author)

2.1. Data collection

Tweets data sampling has been collected for 5 min to 1 hour range, at the same hour for every one day per week starting from 22 November 2021 from a secondary source (Tweet Sentiment Visualization App, n.d.) which feeds live data from Twitter along with bitcoin daily minute range data. The most popular hashtags used were considered as key words for collecting tweets. Due to the lack of free data on other social media platforms, Twitter was selected as the primary tool. Table 2 below illustrates the hashtag considered for the research.

Table 2. Hashtag used to collect data (source: compiled by the author)

Hashtags used for collecting tweets
#Bitcoin
#BTC

2.2. Textual analysis

Textual analysis is a way to gain knowledge about how individuals make sense of and express life and life experiences by deciphering the words, symbols, and/or imagery found in texts. Visual, textual, and spoken information all give hints as to how communication might be read. Because 80 percent of the world's data is in an unstructured format, text analytics is a very profitable activity for businesses. Unstructured documents may be transformed into a structured format using text mining tools and natural language processing (NLP) techniques, allowing for analysis and the development of high-quality insights (IBM, n.d.-a).

2.3. Sentiment analysis

Due to the vast amount of unstructured data, NLP (Natural learning process) was created (Abraham et al., 2018). Natural language processing (NLP) is a subject of computer science, specifically a branch of artificial intelligence (AI), concerning the capacity of computers to interpret text and spoken words in the same manner that humans can (IBM, n.d.-b). For carrying out this research, we used a set of natural language processing tools called "sentiment analysis". Sentiment analysis is a method of determining whether a line of text is positive, negative, or neutral by extracting attitudes and emotions in reaction to goods, promotions, and events by analysing language used in social media postings, answers, reviews, or in other words, it is act of extracting and quantifying subjective feelings or views represented in text (Abraham et al., 2018). Sentiment analysis aids data analysts in major organizations in gauging public sentiment,

performing detailed market research, monitoring brand and product reputation, and comprehending customer experiences (Lexalytics, n.d.). There are multiple ways to carry out Sentimental analysis. For the research, we have chosen VADER (Valence Aware Dictionary for Sentiment Reasoning) model instead of textblob which uses a lexicon to map lexical characteristics to emotion intensities, which are referred to as sentiment scores. Each word in the lexicon is graded in terms of whether it is positive or negative (Beri, 2020) and the primary distinction between TextBlob and VADER is that VADER focuses on social media. As a result, VADER expends considerable effort on analyzing the feelings of content that commonly exist on social media, such as emojis, repeating sentences, and punctuation (Zhuang, n.d.)

3. Textual and sentiment analysis in the cryptocurrency market

To investigate the opinion of people on social media about cryptocurrency popularity using textual and sentimental analysis, MATLAB software has been used to process the textual data and to assign sentiment score to each collected tweet. MATLAB is a programming and numeric computing tool that engineers and scientists use to analyze data, design algorithms, and build models, etc. and the word dictionary used for finding negative and positive words from collected data are from (Hu & Liu, 2004). At first, live tweet data were collected and preprocessed in order to assign sentiment score to the tweets, and later the mean was calculated for each day of the data collected after assigning sentiment score to each tweet. The following is a graphical representation of the mean of tweets collected on a specific date.

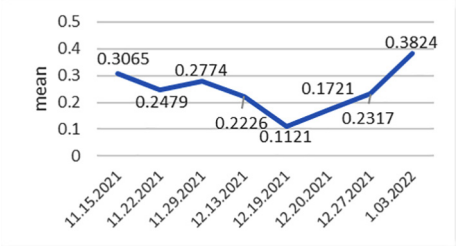

Figure 4. Mean of the tweets collected (source: compiled by the author)

Bitcoin data were considered in minute range for all the days the tweets were collected, and the mean of each day were allocated to bitcoin price during the same minutes and hours the tweet data were collected. Figure 4 illustrates the mean of tweets collected. Below (Table 3) is an example of data arranged before visualization:

As illustrated in Figure 5, it is observed that there is a fluctuation in price during the time frame where sentiment score was allocated. However, we cannot be sure if price fluctuation is a trigger for tweet spikes or if tweets cause the trigger for bitcoin price. To confirm this, the time frame of 15 minutes before and after allocating the sentiment score should be considered. This research is limited to one-minute analysis before and after tweets were collected. Another thing that has been analysed in this research is that whenever the sentiment score is below 0.20, there is a downward movement in price and vice versa.

Table 3. Pre-processed data before visualization (source: compiled by the author)

Date	High	Low	Sentiment Score	Close	Volume BTC	Volume USD
18:20	63 986	63 956	0.3065	63 956	1.055958	67 535.3
18:19	63 981	63 951	0.3065	63 981	0.03374	2158.72
18:18	63 954	63 804	0.3065	63 954	4.286498	27 4137
18:17	63 986	63 931	0.3065	63 931	0.112488	7191.41
18:16	63 996	63 955	0.3065	63 984	0.339008	21 691

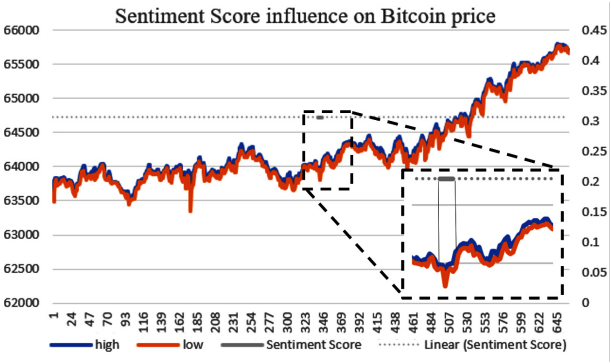

Figure 5. Sentiment score influence on bitcoin price with a detailed view on price fluctuations during the time of sentiment score allocated to bitcoin price (source: compiled by the author)

Conclusions

Cryptocurrency is currently holding trillions of dollars in the market with the gained popularities over the years due to its technology and volatility. The majority of cryptocurrencies are built on decentralized networks known as blockchain technology, which is a distributed ledger enforced by the network's nodes. There are many influencing factors that could determine the fluctuation of bitcoin price, such as cryptocurrency mining, government or celebrity news or even SP500 index etc. However, to find the opinion of people on social media about the cryptocurrency market, the VADER model has been used to allocate the sentiment score to the collected tweets and find the mean of each day's tweets which was later compared to bitcoin price to find a fluctuation. It has been identified through a graphical representation that when sentiment scores were assigned to the price of bitcoin, there was a price fluctuation observed. However, it is impossible to say whether price fluctuations drive tweet spikes or whether tweets cause the price of bitcoin to increase. A time limit of 15 minutes before and after the sentiment score is allocated should be examined to prove this. This study is restricted to a one-minute

analysis before and after tweets were gathered. Another finding of this study is that every time the sentiment score falls below 0.20, there is a negative price movement and vice versa. However, more sophisticated statistical analysis has to be performed to confirm the finding.

The limitations were resource limitation (time), Due to the short period of time only 1 cryptocurrency were considered for this research. This research is limited to one-minute analysis before and after tweets were collected. Another limitation faced was the data availability, Due to the lack of free data on other social media platforms, Twitter was selected as the primary tool.

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