Cryptocurrency Price Analysis

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Abstract

Cryptocurrencies have taken the world by storm when it surfaced as the world's first encounter of digitalized currency alongside the conventional fiat money. Having an internet-based medium of exchange, it leverages on cryptographical functions for financial transactions by utilizing the blockchain technology. Cryptocurrencies are also known for being decentralized, transparent, immutable and unrestricted from the control of central authorities. Essentially, this means that cryptocurrencies are theoretically immune to traditional ways of government control and interference, and that a multitude of factors, ranging from demand and supply, mining, regulations, news and media, affect cryptocurrency price.

The cryptocurrency in study would be bitcoin. This project seeks to build a better understanding of news events' influence on bitcoin price by establishing correlations between bitcoin price and the types of news that actually have an effect on it. This is achieved by: (1) collecting bitcoin prices from 12 April 2019 to 13 March 2020, (2) crawling news titles of Business News, Market News and Bitcoin-related News from 12 April 2019 to 13 March 2020, (3) performing Sentiment Analysis on news titles to obtain their sentiment scores categorized to be positive, neutral or negative, (4) obtaining correlation coefficients of bitcoin price vs sentiment score of news events, (5) plotting time series of bitcoin prices vs sentiment scores of news events, and lastly, (6) analyzing and drawing inferences.

Acknowledgements

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Chapter 1 Introduction

Bitcoin has progressed significantly from the early days where it emerged on the cusp of the 2008 Financial Crisis, from riding on its record-breaking explosive growth in 2017, dwindling in misadventures during the 2018 Great Crypto Crash to maintaining its price stability till date. [1] Starting off at a few dollars, bitcoin's price peaked at nearly USD20,000 in the late-2017 and settled at around USD10,000 as of late-2019. [2] The rise of bitcoin, albeit a couple of ups and downs along the way, has brought about transformative and revolutionary developments in cryptography, blockchain technology and digital transactions. Today, bitcoin is gaining popularity as a payment method and as an investment tool. [3] In fact, the U.S banks are threading on using cryptocurrency for international payments. According to an article by the American Express, U.S banks are developing their digital currencies and blockchain systems as a move to commission business-to-business cryptocurrency payments between their customers. [4] This move came as part of the realized benefits of cryptocurrencies, which include lowered transaction fees and speedier transfers. In February 2019, J.P. Morgan became the first bank to develop a digital coin representative of a fiat currency as an act upon the recognition of the enablement of swift transmission of cliental payments using the blockchain-based technology. [5]

1.1   Problem Statement

Cryptocurrency is a digital cash medium of exchange that capitalizes on cryptography to ensure secure and smooth financial transactions. [6] Invented and developed by Satoshi Nakamoto in 2008, bitcoin is the world's first decentralized cryptocurrency and the world's largest cryptocurrency when measured by market capitalization. [7] Transactions are recorded in a blockchain, with detailed transaction history of each unit of exchange being shown and used to prove ownership. The first real world bitcoin transaction took place in 2010, where a bitcoin miner purchased pizzas for 10,000 bitcoins from Papa John's in Florida, United States of America. Being extremely volatile, bitcoin faces frequent price fluctuations. Observations have shown news events to be one of the critical deciding factors for bitcoin pricing. This stems from the notion that news events shake the market, giving rise to varied sentiments from the public, which then shapes their view of bitcoin and its future prospects, inevitably translating to bitcoin's price point.[8] Thus, the aim of this final year project would be to study the correlation between news events and bitcoin price, to find out the specific type of news events that closely influence bitcoin price.

1.2   Report Organization

This report will be organized as follows:
- Chapter 2 is a literature review on how news events affect bitcoin pricing.
- Chapter 3 describes the program and its implementation.
- Chapter 4 describes the results collected from the implementation of the program.
- Chapter 5 gives a rounding conclusion on the final year project.
- Chapter 6 is the references used in this report.

Chapter 2 Literature Review

This chapter studies existing research literatures explaining news events' extensive edge and influences on bitcoin price. It gives an overview of the general relationship between news events and bitcoin price, a case study of specific news that actually influenced bitcoin's price, an understanding of how Sentiment Analysis comes into picture and takes a look at the existing works that are currently being used.

2.1 Relationship between bitcoin price and news events

Bitcoin prices are volatile and reactive to news events. This comes as a result of its decentralized characteristic, sensitivity to the speculative market and response to investors' sentiment. News events have the ability to change market sentiments, which in turn, prompts investors to take premeditating actions influencing how other investors see bitcoin and its future growth prospects. This in effect is a major determinant to bitcoin price because it essentially only takes one investor with a strong stake hold to cause an acute change in the price of bitcoin. The substantial effect of news events on bitcoin price could either leave prices skyrocketing or plummeting significantly, sometimes in a matter of a few hours, as a response to the extremity of the sentiment derived from a news event. [9]

News events affect the outlook and perspective potential investors hold towards bitcoin, hence contributing considerable weight to investors' confidence and optimism of the bitcoin market. Positive news means positive sentiments. This garners investor's interest and encourages more investors to potentially buy bitcoin. Rising demand results in notable upswings in bitcoin's price. It does not simply stop there. The rising bitcoin price and good sentiments consequently promote what we call the "media hype cycles", which occurs when climbing bitcoin prices attract heavier media coverage, engaging more potential investors to buy and bitcoin price to further appreciate. The cycle would thus continue to prosper until a trigger, in the

form of a change in sentiments, hits. In this case, negative news would cause negative sentiments, sending bitcoin prices to fall very quickly in response to the major sell off investors are rushing into to escape the downfall of the asset class. The burst of the cryptocurrency asset bubble will not only result in landslide prices, but also intensified media coverage, a catalyst forcing even more investors to sell off their current bitcoin holds and avoid purchases if even at all. [10]

Thus, performing Sentiment Analysis on news events to understand the general sentiments could either open up opportunities for a great buy or forewarn traders to halt in their investment tracks and do a sell off as soon as possible to avoid any possibilities of loss. The different types of news events in study, namely – Business News, Market News and Bitcoin-related News, should be a point in consideration because their extent of influence in correlation may vary individually. These regulatory-related news events could essentially concern the "survivability" of bitcoin. For instance, in 2015, the U.S Commodity Futures Trading Commission (CFTC) defined bitcoin and digital currencies to be commodities. [11] This meant that the U.S government could regulate bitcoin, essentially going against the basic principle on which bitcoin was built on – decentralized. Bitcoin, being decentralized, could be exchanged and traded peer-to-peer without the intervention of a financial intermediary or central regulatory authority. Therefore, such regulatory news would shake the cryptocurrency market, and propel prices to spiral out of control.

Hence, there is a need to correlate news events and bitcoin price because the understanding and derivation of average bitcoin price swing could thereby indicate the average daily volatility of bitcoin price in correspondence to news events. By conducting Sentiment Analysis on news events, we could thus obtain the general sentiment scores of news events and draw their correlation to bitcoin price.

2.2 Case study of news events that influenced bitcoin price

In this case study, research conducted by LongHash have shown news events to be the prime driver for bitcoin price, following an observational study documenting the specific news events that triggered changes in bitcoin's price over the entire period of 2018. [12]
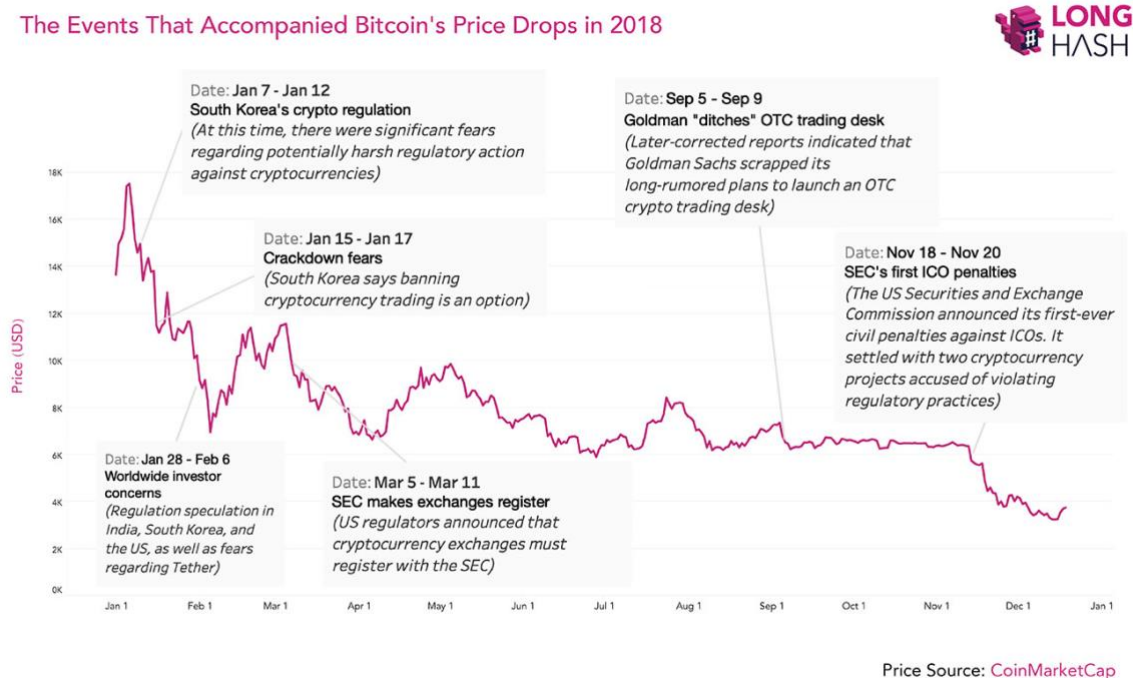
Figure 1: Correlation studies conducted by LongHash

Observing bitcoin price for the period between 7 January 2018 and 12 January 2018, a notable news event that caused bitcoin price to drop by almost 15% from USD16,477.60 (7 January 2018) to USD13,980.60 (12 January 2018) would be South Korea's intention to ban cryptocurrency trade. The coarse and tight impending administration on bitcoin trade were part of South Korean regulators' measures to ward off illegal profiteering from crypto trades. This abrupted major uncertainty in the market and steered bitcoin price in the downhill trajectory. [13] Bitcoin's price continued to fall by about 19% from 15 January 2018 and 17 January 2018, from

USD13, 819.80 (15 January 2018) to USD11, 188.60 (17 January 2018) as a result of investors' averse and uneasy sentiments from the aforementioned proposed cryptocurrency ban by the South Korean regulators. This persisted to the period between 28 January 2018 and 6 February 2018, where the growing concerns of international investors caused bitcoin's price to continue dropping noticeably by up to 34% from USD11,786.30 (28 January 2018) to USD7,754.00 (6 February 2018). Although we cannot attribute the fall in bitcoin price solely to the sentiments gathered from news events, we can observe the seemingly significantly strong correlation between bitcoin's price and the above regulatory news event.

2.3   Understanding Sentiment Analysis

Today, analysis of sentiments has proven to be the way forward in identifying promising and trusted indicators when making trade decisions for bitcoin. A field of Natural Language Processing (NLP), Sentiment Analysis is the identification, perception and categorization of tone and emotions within textual data using text analysis techniques. [14] Sentiment Analysis allows organic emotions behind the textual data to be uncovered, and sentiments to be identified, by measuring polarity so as to derive indicatives of the textual data's associativity towards the positives and the negatives. The U.S Securities and Exchange Commission (SEC) have revealed their plan to capitalize on social media Sentiment Analysis tools to keep an eye on the cryptocurrency market. Albeit not the main focus point, social media Sentiment Analysis supplements current market data information to help the SEC watch the evolving scene. [15] Sentiment Analysis has thus become an essential component in deciphering the masses' emotional feels and opinions towards various news events since bitcoin's valuation is largely investor sentiment driven.

2.4   Existing works in the market

In this section of the literature review, existing solutions and works that are currently used in the market will be studied.

2.4.1 Twitter Sentiment Analysis

Some of the sources of textual data ranges from news websites (e.g. Reuters, Bloomberg, CNBC, The New York Times, The Wall Street Journal, Google News, Yahoo! News, etc.) to social media (e.g. Facebook, Instagram, Twitter, Reddit, etc.). Amongst them, one of the majorly used source of textual data for bitcoin's price Sentiment Analysis would be the tweets from Twitter. Twitter is an American social networking service providing a platform where users could interact virtually via a 280-words "tweet".
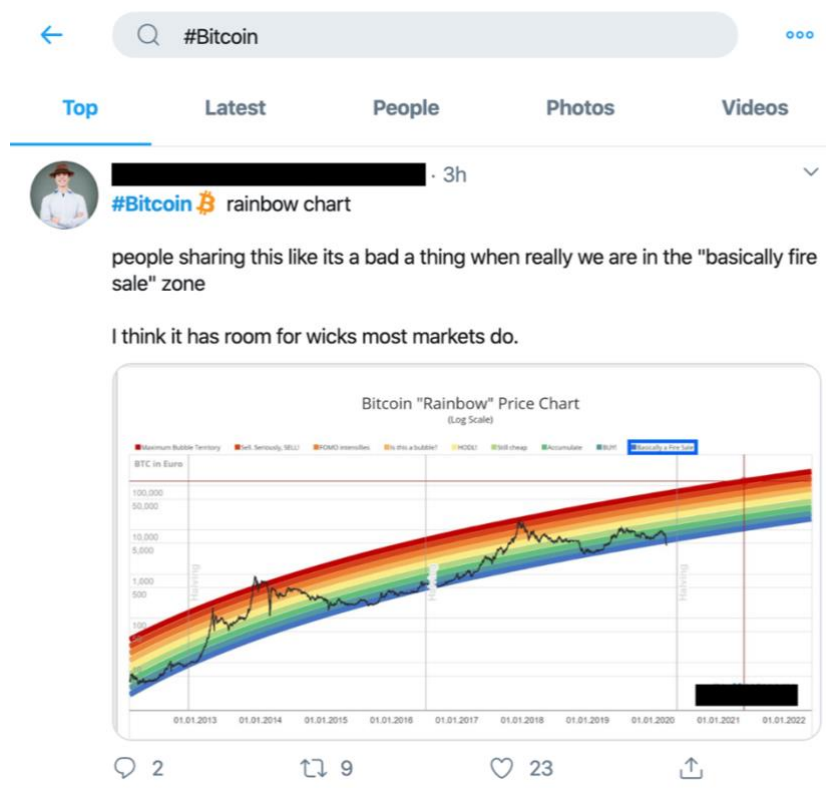
Figure 2: Example of a #Bitcoin related search result

Tweets have been used in Sentiment Analysis as a yardstick to guess the predominant mood present in the 280-words and to establish trade patterns. Tweet volumes seem to give a clue about market movements and the overall optimism. [16] Twitter shows market fluctuations, denoting the variation in supply and demand of bitcoin that comes with the changing emotions and perception of investors. [17]

2.4.2 *The TIE*

Based in New York, *The Tie* is an analytics platform that looks out for potential cryptocurrency trading opportunities for investors. It offers useful insights and market data using predictive Sentiment Analytics to keep investors well-tuned and involved in the cryptocurrency market. Social sentiments provided include metrics like tweet volume, Network Value / Daily Transaction Volume (NVT) ratios, moving averages and short-term sentiment score. Cryptocurrency hourly price projections are also estimated using the forecasted percentage change in cryptocurrency price within the period of one hour. Using the aforementioned statistics like social sentiments and cryptocurrency hourly price projections, The Tie can gauge the current sentiment towards cryptocurrencies more accurately and draw correlations between the sentiment towards a cryptocurrency and its future price. This allows investors to determine the general actionability (buy/sell/hold) of the cryptocurrency. [18]
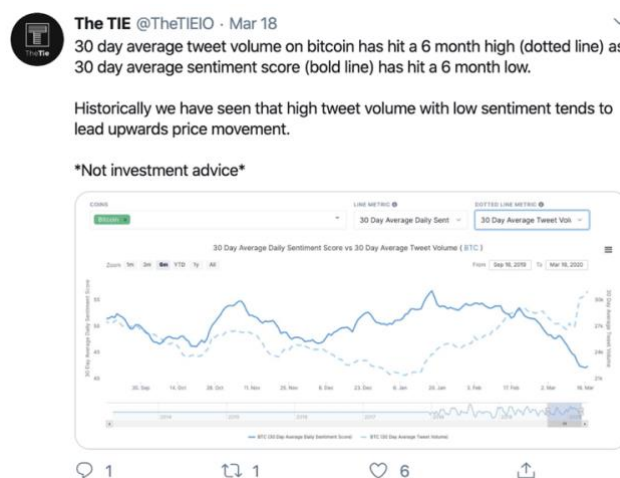
Figure 3: *The TIE* uses tweet volume and sentiment score as investment metrics

2.5   Literature Review Conclusion

Therefore, previous research shown that bitcoin prices is not depicted by a single sole source, but rather, a mixture of factors with slightly stronger dependence on news events. It is clear that insights derived from Sentiment Analysis are of slight significant impact, often an inkling of the returns investors' could receive, where the sentiment metrics complement investor's ability to determine the period of speculation, aiding them to adjust their investment strategies accordingly to capitalize on bull or bear trends.

Chapter 3 Program Design & Implementation

3.1 Overview

The purpose of this final year project would be to examine how sentiments derived from news events relate to bitcoin's prices, and in particular, the specific type of news events that correlates strongly with bitcoin's price.

The workflow of this project would be to: (1) obtain bitcoin prices from CoinMarketCap for the period of 12 April 2019 to 13 March 2020, (2) code out a web scraper to crawl for news titles of Business News, Market News and Bitcoin-related News for the period of 12 April 2019 to 13 March 2020, (3) perform Sentiment Analysis on the collected news events to obtain their sentiment scores, (4) perform Correlation Analysis to obtain correlation coefficients of bitcoin's price vs sentiment scores of news events, (5) perform Time Series Analysis to obtain time series plots of bitcoin's price vs sentiment scores of news events, and lastly, (6) analyze and draw inferences to understand the correlation between bitcoin's price and public sentiments towards the different types of news events.

3.2 Tools & Data Sources used

Tools used in this project:
- PyCharm (Python)
- RStudio (R)
- Microsoft Excel

Data sources:
- CoinMarketCap
- Reuters

3.3 CoinMarketCap

Based in New York, United States of America, CoinMarketCap is a website launched on 28 April 2013 providing financial metrics tracking and market analysis for all cryptocurrencies. Current and historical bitcoin prices are collected from CoinMarketCap. Data extraction include Date, Open, High, Low, Close, Volume and Market Cap in United States Dollar (USD) from 12 April 2019 to 13 March 2020.

Open represents the opening price of bitcoin, which is the first price at which bitcoin is traded at once the market opens. High represents the highest price bitcoin hits in the day. Low represents the lowest price bitcoin reached in the day. Close represents the last price at which bitcoin is traded at before the market closes. Volume represents the total amount of bitcoins traded from market open till market close. Market cap represents the market capitalization of bitcoin, it measures the value of bitcoin and is defined by the circulating supply of bitcoin tokens multiplied by the current bitcoin price.

During the data exploration process, data quality was verified to be high as no corrupted or inaccurate records were identified. Subsequently, for the data preparation process, the following columns were selected: Date, Open, High, Low,

Close, Volume, Market Cap. Data were formatted appropriately to be DD/MM/YYYY, while Open, High, Low, Close, Volume and Market Cap were formatted to numerically hold 2 decimal places.

Date	Open	High	Low	Close	Volume	Market Cap
12/04/2019	5061.20	5103.27	4955.85	5089.54	13675206312.00	89792633045.00
13/04/2019	5088.85	5127.12	5061.59	5096.59	10823289598.00	89925574875.00
14/04/2019	5095.76	5184.02	5053.57	5167.72	10391952498.00	91188595341.00
15/04/2019	5167.32	5196.61	5024.07	5067.11	12290155061.00	89422237603.00
16/04/2019	5066.58	5238.95	5055.19	5235.56	11618660197.00	92404613297.00
17/04/2019	5236.14	5274.28	5219.21	5251.94	12438480677.00	92702617458.00
18/04/2019	5251.48	5319.99	5250.51	5298.39	13256489918.00	93532402741.00
19/04/2019	5298.15	5336.68	5233.34	5303.81	13780238655.00	93638345002.00
20/04/2019	5304.16	5358.49	5295.88	5337.89	13169647522.00	94248717444.00
21/04/2019	5335.88	5359.93	5257.34	5314.53	13731844223.00	93847052256.00

Figure 4: Snippet of the collected bitcoin OHLC prices

3.4 Reuters

Owned by Thomson Reuters, Reuters is an international news organization that provides financial market data. Headquartered in London, United Kingdom, it offers the most updated global news, covering markets, business, politics, entertainment, technology and many more.

News events are solely sourced from Reuters to ensure a consolidated and singular platform for reliable and trusted business financial news retrieval. Headlines of the news events with the keyword "Bitcoin" and "Cryptocurrency" were scraped to ensure specificity and receive targeted results. News events from various topics ranging from – Business and Markets, for the period between 12 April 2019 and 13 March 2020 were also scraped. Upon scraping, data extraction included Title and

Date. During the data exploration process, data duplication in terms of the same title was observed. News with the same title might sometimes be posted at least twice on the same event at different times as a result of updates from the news agency. Closer inspection revealed that their news contents do differ despite their same title. Data was thus preserved as its removal could result in data loss. Subsequently, for the data preparation process, the following columns were selected: Date, Title, where dates were formatted to be DD/MM/YYYY, and the title's original format was preserved.

Senate Democrats ask Fed's Powell about repo market ahead of hearing	12/03/2020
IMF approves $20 mln loan tranche to Moldova	12/03/2020
US STOCKS-U.S. stock futures tumble as Trump's coronavirus response disappoints	12/03/2020
RPT-Surge in jobseekers to test Turkey's strained labour market	12/03/2020
CORRECTED-FOREX-Dollar slides as Trump's virus response disappoints	12/03/2020
PRESS DIGEST - Wall Street Journal - March 12	12/03/2020
Virus volatility a shot in the arm for China's dormant derivatives market	12/03/2020
Mexico must minimize coronavirus economic drag, finance minister says	12/03/2020
GLOBAL MARKETS-Financial markets reel, stocks plunge as Trump stuns with Europe travel ban	12/03/2020
Greece reports first coronavirus death, 66 year old man	12/03/2020
Japan large manufacturers' mood sours to near 9-year low from coronavirus jolt	12/03/2020
Freed from impeachment drama, Trump to press ahead with re-election campaign	12/03/2020
Factbox: Trump impeachment - What happens next?	12/03/2020
Explainer: Why will Republicans vote to acquit Trump in his impeachment trial?	12/03/2020
Japan's record buying of foreign debt hints at pension fund support	11/03/2020
Japan shares dive deeper into bear market as Trump stuns with Europe travel ban	11/03/2020
Morning News Call - India, March 12	11/03/2020
U.S. House Democrats unveil new coronavirus response bill	11/03/2020
BOJ Governor Kuroda to meet PM Abe - Jiji	11/03/2020
FOREX-Dollar slides after Trump bans travel from Europe to fight virus	11/03/2020

Figure 5: Snippet of the collected news events

3.5   Sentiment Analysis

Natural Language Toolkit (NLTK) is Python's Natural Language Processing (NLP) library used for Sentiment Analysis. Valence Aware Dictionary and sEntiment Reasoner (VADER) is a pre-built lexicon and rule-based Sentiment Analysis Artificial Intelligence tool that measures the polarity of textual data according to the tone, extent of positivity and negativity observed, and magnitude of emotions incorporated. Using the established sentiment lexicon that holds textual data labelled correspondingly to their semantic bearings, individual news titles would be parsed text by text, where each text within the sentence hold an intensity value. Eventually, the news title would be rated with a compounded sentiment score based on the overall normalized sum of intensity measured by adding the intensity scores of all texts in the sentence. Analysis of sentiments mainly stems from 5 aspects: 1) Punctuation –Punctuations like the exclamation mark (!) heightens the magnitude of the intensity, 2) Capitalization – Upper case letters heightens the magnitude of the intensity, 3) Degree modifiers – Intensifiers can modify the magnitude of the intensity based on their underlying connotation, 4) Conjunction – Conjunctions can cause a sudden shift in polarity, 5) Preceding Tri-gram – Catching the tri-gram that comes before a sentiment-laden lexical feature could cause a total reversal of the initial sentiment. [19]

```
Producing bitcoin currency could void climate change efforts – scientists {'neg': 0.0, 'neu': 1.0, 'pos': 0.0, 'compound': 0.0} Neutral
Factbox: Ten years of bitcoin----------- {'neg': 0.0, 'neu': 1.0, 'pos': 0.0, 'compound': 0.0} Neutral
Birthday blues for bitcoin as investors face year-on-year loss {'neg': 0.223, 'neu': 0.777, 'pos': 0.0, 'compound': -0.3182} Negative
Early bitcoin investors count winnings after volatile decade {'neg': 0.0, 'neu': 0.667, 'pos': 0.333, 'compound': 0.5423} Positive
UPDATE 1-Birthday blues for bitcoin as investors face year-on-year loss {'neg': 0.204, 'neu': 0.796, 'pos': 0.0, 'compound': -0.3182} Negative
Birthday blues for bitcoin as investors face year-on-year loss {'neg': 0.223, 'neu': 0.777, 'pos': 0.0, 'compound': -0.3182} Negative
RPT-Early bitcoin investors count winnings after volatile decade {'neg': 0.0, 'neu': 0.667, 'pos': 0.333, 'compound': 0.5423} Positive
Breakingviews – Bitcoin remains a triumph of hope over experience {'neg': 0.0, 'neu': 0.5, 'pos': 0.5, 'compound': 0.7184} Positive
New York regulator grants virtual license to bitcoin ATM operator {'neg': 0.0, 'neu': 0.826, 'pos': 0.174, 'compound': 0.2263} Neutral
```

Figure 6: Sample of the calculated sentiment scores of news titles

3.6 Correlation Analysis

Correlation Analysis is a statistical method conducted to understand the strength of relationship between variables involved. Correlation coefficient is a value between negative one (-1) and positive one (+1), with +1 and -1 representing perfect correlation, 0 representing zero correlation, and all values in between 0 and -1, 0 and 1, representing partial correlation corresponding to their magnitude significance. [20]

Strong correlation establishes a highly dependent relationship between the variables, whereas weak correlation embodies that the variables are hardly related. [20] Using R, Correlation Analysis is performed for bitcoin's price and sentiment score of news titles. Correlation coefficients were obtained from the Correlation Analysis of 1) bitcoin's price vs Business News' sentiment score, 2) bitcoin's price vs Market News' sentiment score and 3) bitcoin's price vs Bitcoin News' sentiment score.

	Open	High	Low	Close	Volume	Market.Cap	Index
Open	1.0000000	0.9861471	0.9847517	0.9619927	0.71083169	0.9635918	0.22640071
High	0.9861471	1.0000000	0.9847365	0.9861934	0.73321492	0.9870189	0.22052593
Low	0.9847517	0.9847365	1.0000000	0.9867188	0.66437117	0.9870303	0.24977097
Close	0.9619927	0.9861934	0.9867188	1.0000000	0.68653411	0.9996845	0.23846568
Volume	0.7108317	0.7332149	0.6643712	0.6865341	1.00000000	0.6946089	0.08388436
Market.Cap	0.9635918	0.9870189	0.9870303	0.9996845	0.69460889	1.0000000	0.23372691
Index	0.2264007	0.2205259	0.2497710	0.2384657	0.08388436	0.2337269	1.00000000

Figure 7: Sample results of correlation coefficients of bitcoin OHLC price and sentiment score

3.7 Time Series Analysis

Time Series analysis is a series of data points indexed over a set time interval. The time series plots for bitcoin's prices between 12 April 2019 and 13 March 2020 is shown (Figure 8) in the form of a candlestick chart. Time series for bitcoin's price vs sentiment scores of news event for the time period between 12 April 2019 to 13 March 2020 will also be plotted to graphically show the inter-variable correspondence over time.

Figure 8: Time Series plot of bitcoin price (USD)

Time series plots allow us to understand bitcoin's general pricing trends, direction of fluctuation and predict future bitcoin price. It illustrates the movements of bitcoin prices over time.

Chapter 4 Results

This chapter describes the results of the bitcoin price analysis between the period of 12 April 2019 and 13 March 2020. Sentiment scores derived from Sentiment Analysis, correlation coefficients derived from Correlation Analysis and time series plots derived from Time Series Analysis will be analyzed.

4.1   Sentiment Scores

Upon conducting Sentiment Analysis, a compounded sentiment score is obtained for every news title. It can be classified into 3 main classes: Positive, Neutral and Negative. Between the range of 1 and -1, sentiment scores that are greater than or equal to 0.5 will be considered Positive. Sentiment scores that are greater than or equal to 0 but less than 0.5 will fall under Neutral. Finally, sentiment scores that are lesser than 0 will be considered Negative.

Sentiment Score	Class
>= 0.5	Positive
>= 0, < 0.5	Neutral
< 0	Negative

Figure 9: Classification classes of sentiment scores

Bitcoin, gas & smart power: RCMA Group plans energy expansion {'neg': 0.0, 'neu': 0.593, 'pos': 0.407, 'compound': 0.5859} Positive
REUTERS SUMMIT-Bitcoin, gas & smart power: RCMA Group plans energy expansion {'neg': 0.0, 'neu': 0.625, 'pos': 0.375, 'compound': 0.5859} Positive

Figure 10: Samples of news titles classified Positive

Goldman Sachs to clear bitcoin futures —spokeswoman {'neg': 0.0, 'neu': 0.698, 'pos': 0.302, 'compound': 0.3818} Neutral
Cboe, CME to launch bitcoin futures contracts {'neg': 0.0, 'neu': 1.0, 'pos': 0.0, 'compound': 0.0} Neutral

Figure 11: Samples of news titles classified Neutral

Forget Bitcoin bubble – will Fevertree go pop? {'neg': 0.241, 'neu': 0.759, 'pos': 0.0, 'compound': -0.2263} Negative
Bitcoin warnings grow more strident as Singapore urges extreme caution {'neg': 0.196, 'neu': 0.804, 'pos': 0.0, 'compound': -0.296} Negative

Figure 12: Samples of news titles classified Negative

Subsequently, a final sentiment score for the day will be computed by summing up all individual sentiment scores of news titles collected in the day itself.

Date	Sentiment Score
27/12/2019	0.011
28/12/2019	0.076
29/12/2019	-0.113
30/12/2019	0.012
31/12/2019	-0.051
01/01/2020	-0.016
02/01/2020	-0.121
03/01/2020	-0.059
04/01/2020	-0.038
05/01/2020	-0.022
06/01/2020	0.021
07/01/2020	-0.061
08/01/2020	-0.066
09/01/2020	0.035

Figure 13: Sentiment scores for the day

The sentiment score for the day gives a general feel of the situation of the world market at large, as to whether it is optimistic or not. It also gives a sensing of the public's overall inclination towards the current market situation.

Taking some of the news events that happened on 18 April 2019 (Figure 14) and its sentiment score for the day (Figure 15) for instance, they do indeed seemingly correspond.

HNA denies embezzlement claims as it fights for control of Hong Kong Airlines	18/04/2019
Tesla's Elon Musk, SEC get another week to work out deal on Twitter use	18/04/2019
Exclusive: New York Fed cracks down on Puerto Rico banks following Venezuela sanctions	18/04/2019
National Enquirer to be sold to owner of magazine distributor	18/04/2019
Oil prices inch up on signs of tighter global supply	18/04/2019
Uber's self-driving unit valued at $7.25 billion in new investment	18/04/2019
Earnings deluge could make or break sentiment	18/04/2019
U.S. wins WTO ruling against China grain import quotas	18/04/2019
Sears sues Lampert, claiming he looted assets and drove it into bankruptcy	18/04/2019
New North American trade deal modestly boosts U.S. economy, trade panel finds	18/04/2019
Air Canada pilots reviewing aircraft systems on Boeing's MAX jets	18/04/2019
Exclusive: Spain's Repsol suspended swap deal for Venezuelan oil under U.S. pressure	18/04/2019
Wall Street closes slightly higher, industrials lead	18/04/2019
Potential Fed nominee Cain says not withdrawing from consideration	18/04/2019
Pinterest, Zoom shares surge in market debuts after IPOs	18/04/2019
Risk of U.S. 'profit recession' eases as results beat forecasts	18/04/2019
Stocks mixed as strong U.S. retail sales offset weak European manufacturing data	18/04/2019
GM CEO Barra's pay dipped slightly to just under $22 million in 2018	18/04/2019
U.S. lawmakers to get long-awaited analysis of new NAFTA deal	18/04/2019
Automakers invest heavily in electric vehicles despite still-low demand	18/04/2019
EssilorLuxottica shareholder body propose independent director to ease deadlock	18/04/2019
U.S. retail sales, labor market data paint upbeat economic picture	18/04/2019
U.S. trade agency sees 76,000 new auto jobs from North American trade deal	18/04/2019
Zoom starts trading at $65 per share, 80 percent above IPO price	18/04/2019
German ministry wants to extend electric car subsidies: document	18/04/2019
Explainer: Betting on the past? Europe decides on connected car standards	18/04/2019
Exclusive: New U.S. consumer watchdog chief to continue review of complaints database, fair lendin	18/04/2019
U.S. pilot program allows online grocery shopping with food stamps	18/04/2019
Google lets Android users in Europe choose rival browsers, search engines	18/04/2019
Hermes CEO steps down from L'Oreal board over competing make-up line	18/04/2019
Jet Airways shares plunge, rivals race to grab grounded carrier's slots	18/04/2019
India to temporarily allocate Jet Airways slots to rival carriers: official	18/04/2019
AmEx profit beats as rewards program boosts customer spending	18/04/2019
Who will succeed Carney to run Britain's central bank?	18/04/2019
Honeywell evaluating revenue potential from Boeing's next aircraft launch: CFO	18/04/2019
Honeywell expects Boeing 737 MAX deliveries to resume in the second half of 2019	18/04/2019
McDonald's pulls Signature Crafted burgers, doubles down on Quarter Pounders	18/04/2019
Schlumberger posts profit drop, sees international spending rising	18/04/2019
Airbus sells longer-range A321, expects quick end to Boeing crisis	18/04/2019
France points way for UK shake up of audit market	18/04/2019
New Apple lab uses robots to rip apart devices for recycling materials	18/04/2019
Daimler to seek 6 billion euros in cost savings at Mercedes: Manager Magazin	18/04/2019
Abraaj founder's extradition case adjourned, another former executive arrested: court official	18/04/2019
U.S. retail sales post biggest gain in one-and-a-half years in March	18/04/2019

Figure 14: Snippet of some news events that happened on 18 April 2019

Date	Score
13/04/2019	0.062
14/04/2019	-0.065
15/04/2019	-0.056
16/04/2019	0.088
17/04/2019	0.077
18/04/2019	0.087
19/04/2019	0.079
20/04/2019	0.013

Figure 15: Sentiment scores on 18 April 2019

Date	Open	High	Low	Close	Volume	Market Cap	Score
13/04/2019	5088.85	5127.12	5061.59	5096.59	10823289598.00	89925574875.00	0.062
14/04/2019	5095.76	5184.02	5053.57	5167.72	10391952498.00	91188595341.00	-0.065
15/04/2019	5167.32	5196.61	5024.07	5067.11	12290155061.00	89422237603.00	-0.056
16/04/2019	5066.58	5238.95	5055.19	5235.56	11618660197.00	92404613297.00	0.088
17/04/2019	5236.14	5274.28	5219.21	5251.94	12438480677.00	92702617458.00	0.077
18/04/2019	5251.48	5319.99	5250.51	5298.39	13256489918.00	93532402741.00	0.087
19/04/2019	5298.15	5336.68	5233.34	5303.81	13780238655.00	93638345002.00	0.079
20/04/2019	5304.16	5358.49	5295.88	5337.89	13169647522.00	94248717444.00	0.013
21/04/2019	5335.88	5359.93	5257.34	5314.53	13731844223.00	93847052256.00	0.209
22/04/2019	5312.49	5422.69	5280.28	5399.37	14601631648.00	95354207776.00	0.153
23/04/2019	5399.37	5633.80	5389.41	5572.36	15867308108.00	98417387004.00	-0.028
24/04/2019	5571.51	5642.04	5418.26	5464.87	17048033399.00	96530038144.00	0.031
25/04/2019	5466.52	5542.24	5181.34	5210.52	15330283408.00	92046492864.00	0.095
26/04/2019	5210.30	5383.63	5177.37	5279.35	16812108040.00	93272287960.00	-0.035
27/04/2019	5279.47	5310.75	5233.64	5268.29	13111274675.00	93086156556.00	0.043
28/04/2019	5271.75	5326.23	5255.68	5285.14	12819992056.00	93391244395.00	-0.02
29/04/2019	5284.86	5311.27	5216.49	5247.35	13735490672.00	92737510865.00	-0.022
30/04/2019	5247.73	5363.26	5224.19	5350.73	13878964574.00	94573826827.00	0.087
01/05/2019	5350.91	5418.00	5347.65	5402.70	13679528236.00	95501110091.00	0.102
02/05/2019	5402.42	5522.26	5394.22	5505.28	14644460907.00	97330112147.00	0.084
03/05/2019	5505.55	5865.88	5490.20	5768.29	18720780006.00	102000000000.00	-0.067
04/05/2019	5769.20	5886.89	5645.47	5831.17	17567780766.00	103000000000.00	0.081
05/05/2019	5831.07	5833.86	5708.04	5795.71	14808830723.00	102000000000.00	-0.036

Figure 16: Snippet of the consolidated table that includes both bitcoin OHLC prices and sentiment scores for Business News

Date	Open	High	Low	Close	Volume	Market Cap	Score
27/04/2019	5279.47	5310.75	5233.64	5268.29	13111274675.00	93086156556.00	0
28/04/2019	5271.75	5326.23	5255.68	5285.14	12819992056.00	93391244395.00	0.015
29/04/2019	5284.86	5311.27	5216.49	5247.35	13735490672.00	92737510865.00	0.296
30/04/2019	5247.73	5363.26	5224.19	5350.73	13878964574.00	94573826827.00	0.059
01/05/2019	5350.91	5418.00	5347.65	5402.70	13679528236.00	95501110091.00	0.033
02/05/2019	5402.42	5522.26	5394.22	5505.28	14644460907.00	97330112147.00	0.042
03/05/2019	5505.55	5865.88	5490.20	5768.29	18720780006.00	102000000000.00	0.044
04/05/2019	5769.20	5886.89	5645.47	5831.17	17567780766.00	103000000000.00	0.012
05/05/2019	5831.07	5833.86	5708.04	5795.71	14808830723.00	102000000000.00	0.031
06/05/2019	5791.69	5802.96	5653.69	5746.81	15737171804.00	102000000000.00	-0.183
07/05/2019	5745.60	5988.18	5741.40	5829.50	18026409033.00	103000000000.00	-0.093
08/05/2019	5849.48	5989.98	5794.72	5982.46	15320605300.00	106000000000.00	-0.095
09/05/2019	5982.32	6183.04	5982.32	6174.53	16784645411.00	109000000000.00	-0.082
10/05/2019	6175.82	6434.62	6161.52	6378.85	19419875368.00	113000000000.00	-0.056
11/05/2019	6379.67	7333.00	6375.70	7204.77	28867562329.00	127000000000.00	0.005
12/05/2019	7203.51	7503.87	6815.77	6972.37	27773333680.00	123000000000.00	0.106
13/05/2019	6971.18	8047.41	6898.28	7814.92	28677672181.00	138000000000.00	-0.254
14/05/2019	7807.88	8268.71	7696.39	7994.42	32031452227.00	142000000000.00	-0.157
15/05/2019	7989.37	8216.42	7899.11	8205.17	28344112920.00	145000000000.00	-0.062

Figure 17: Snippet of the consolidated table that includes both bitcoin OHLC prices and sentiment scores for Market News

It can be observed that sentiment scores for the day can vary significantly when you are focusing on different types of news events. Solely focusing on 28 April 2019, we can see that sentiment score for the day for Business News (Figure 16) is -0.02, whereas the sentiment score for the day for Market News (Figure 17) is 0.015. Thus, different types of news events return different sentiment scores, and it is inconclusive at this stage to solely attribute bitcoin price change to a sole category of news event. There is a possibility that bitcoin price change is a result of a few specific and targeted significant news events that happened, rather than to base and correlate it on a whole category of news events.

4.2   Correlation Coefficients

To understand the correlation between specific news events and change in bitcoin's price, a Correlation Analysis was conducted to uncover the depth and extent of correlation in their relationship. Several sets of consolidated data were used to determine how different types of news events affect bitcoin prices – namely, bitcoin OHLC prices with sentiment score of Business News, bitcoin OHLC prices with sentiment score of Market News, and bitcoin OHLC prices with sentiment score of Bitcoin-related News.

	Open	High	Low	Close	Volume	Market.Cap	Score
Open	1.0000000	0.99012609	0.98550831	0.97511187	0.136135447	0.97491884	-0.104372197
High	0.9901261	1.00000000	0.98109760	0.98742944	0.166244941	0.98568341	-0.096445326
Low	0.9855083	0.98109760	1.00000000	0.98982875	0.092342554	0.99013704	-0.100111449
Close	0.9751119	0.98742944	0.98982875	1.00000000	0.129223252	0.99865232	-0.095551367
Volume	0.1361354	0.16624494	0.09234255	0.12922325	1.000000000	0.15757220	-0.009739196
Market.Cap	0.9749188	0.98568341	0.99013704	0.99865232	0.157572197	1.00000000	-0.096882327
Score	-0.1043722	-0.09644533	-0.10011145	-0.09555137	-0.009739196	-0.09688233	1.000000000

Figure 18: Correlation coefficients for bitcoin OHLC prices vs sentiment score of
Business News

	Open	High	Low	Close	Volume	Market.Cap	Score
Open	1.00000000	0.9856928	0.978779984	0.96631666	0.064222233	0.96611979	-0.13172967
High	0.98569281	1.0000000	0.971928414	0.98252385	0.103943574	0.98007218	-0.14408341
Low	0.97877998	0.9719284	1.000000000	0.98661380	0.009072967	0.98723232	-0.13438306
Close	0.96631666	0.9825238	0.986613801	1.00000000	0.056404034	0.99837736	-0.14289288
Volume	0.06422223	0.1039436	0.009072967	0.05640403	1.000000000	0.08607087	-0.06912479
Market.Cap	0.96611979	0.9800722	0.987232315	0.99837736	0.086070867	1.00000000	-0.14073232
Score	-0.13172967	-0.1440834	-0.134383061	-0.14289288	-0.069124785	-0.14073232	1.00000000

Figure 19: Correlation coefficients for bitcoin OHLC prices vs sentiment score of
Market News

Some observations that could be drawn from the results of the correlation studies include: (1) From Figure 18, strong correlation between bitcoin's price and sentiment score of Business News cannot be observed, (2) From Figure 19, strong correlation between bitcoin's price and sentiment score of Market News cannot be observed. It could be that the large amount of news events collected possibly toned down the overall significance of the sentiment of several major news events, since the

sentiments scores are compounded altogether. Thus, sentiments appear to not significantly affect bitcoin prices to a large extent, when in fact, there could be a few news events that significantly change bitcoin's price.

News events actually do in effect influence bitcoin prices, but on varying levels and degrees, with a high dependency on context. To further explain on this point, we can refer to the 36% sudden fall in price on 13 March 2020, where bitcoin prices fell from USD7913.62 (12 March 2020) to USD5017.83 (13 March 2020). Pointing to the figures shown below, it might sometimes take very specific market situations and events to trigger the fluctuation in bitcoin prices.

Factbox: Latest on the spread of coronavirus around the world	13/03/2020
North Korea had military forces on lockdown for 30 days over coronavirus - U.S. general	13/03/2020
Bulgaria bans travel to Iran, raises risk on travels to 11 countries	13/03/2020
Fed's economic forecasts to give window into extent of coronavirus fears	13/03/2020
Why Brazilian airline shares are hardest hit by the coronavirus panic	13/03/2020
Airline SAS to cut, suspend U.S. flights	13/03/2020
North Macedonia bars foreigners arriving from 'high-risk countries' over coronavirus	13/03/2020
UK's Johnson to talk to world leaders on coronavirus response: spokesman	13/03/2020
Iraq puts Germany and Qatar on coronavirus entry ban list	13/03/2020
Ethiopia confirms its first case of coronavirus	13/03/2020
What you need to know about coronavirus today	13/03/2020
Czech government bans most travel in and out of country to fight coronavirus	13/03/2020
South Korea reports more recoveries than coronavirus cases for the first time	13/03/2020
Zhang Yiming, founder of TikTok owner ByteDance, gears up for the global stage	13/03/2020
U.S. companies draw on credit lines, fearing they may lose them	13/03/2020
After miracle recovery, Fukushima brewers look to the Games to push sake globally	13/03/2020
Buffett-backed Chinese EV maker BYD says making 5 million masks daily to fight virus	13/03/2020
Canada's Trudeau to be in isolation after wife tests positive for coronavirus	13/03/2020
Starbucks to invest $130 million for roasting plant in China's Kunshan	13/03/2020
Hong Kong records fourth coronavirus-related death - hospital spokeswoman	13/03/2020
Singapore to bar recent visitors to Italy, Spain, Germany, France	13/03/2020
Bob Dylan concerts in Japan canceled as coronavirus spreads	13/03/2020

Figure 20: Snippet of Business News events that happened on 13 March 2020

U.S. excludes some Chinese medical products from tariffs	12/03/2020
Juul co-founder James Monsees plans to leave	12/03/2020
Washington state repeals pro-Boeing tax break; U.S. hopes to avoid EU tariffs	12/03/2020
Airbus: End of Washington state tax break of Boeing just 'initial step'	12/03/2020
Global airlines call for government aid and United warns of cuts to U.S. routes	12/03/2020
U.S. airlines capping fares from Europe as Americans seek flights home	12/03/2020
Ford takes aim at Jeep with new Bronco SUVs	12/03/2020
Canada revising deal aimed at validating U.S.-certified planes	12/03/2020
Wall Street dazed and confused after worst day since 1987	12/03/2020
Wall Street sell-off batters bitcoin, pounds palladium as investors go to cash	12/03/2020
Walgreens, Kroger limit purchase of some essential products amid virus outbreak	12/03/2020
Gap sees 2020 profit above estimates, flags $100 mln virus hit to sales	12/03/2020
Business jet operators see demand surge on U.S. travel restrictions, coronavirus	12/03/2020
Broadcom withdraws 2020 revenue forecast on coronavirus worries	12/03/2020
Plunging Wall Street stocks end record bull run	12/03/2020
Wall Street's 'fear gauge' marks record surge after stock sell-off	12/03/2020
Oracle's cloud push powers quarterly profit, revenue beat	12/03/2020
Slack shares slump on soft outlook, slower growth	12/03/2020
Amazon tells staff globally to work from home if possible	12/03/2020
AT&T waives data overage fees for home subscribers; Comcast boosts speeds for some users	12/03/2020
Banks remind customers they can bank online amid coronavirus outbreak	12/03/2020
Wall Street empties out as New York City declares state of emergency	12/03/2020
Panic grips financial markets after U.S. travel curbs, ECB move	12/03/2020
As Trump's stock market gains shrink, he says it will 'work out fine'	12/03/2020
United to scale back flights to Europe after March 19	12/03/2020
Boeing shares plummet as travel restrictions hit airlines	12/03/2020
JetBlue CEO latest airline executive to take salary cut amid coronavirus	12/03/2020
Trump signs law to prevent U.S. rural telecom carriers from using Huawei network equipment	12/03/2020
Airbnb bookings take hit amid global coronavirus outbreak	12/03/2020
Oil falls 7% after Trump surprises with travel curbs	12/03/2020
Rio Tinto to pay ex-CEO's deferred bonus with interest	12/03/2020
Explainer: Fed may go into its crisis tool kit soon. What's in it?	12/03/2020
Verizon raises 2020 capital expenditure in 5G push	12/03/2020

Figure 21: Snippet of Business News events that happened on 12 March 2020

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Occidental adopts "poison pill" after Icahn raises stake to about 10%	13/3/20
UPDATE 1-EU to offer greater leeway under fiscal rules for crisis spending	13/3/20
UK's Prince Charles cancels tour of Bosnia, Cyprus and Jordan over coronavirus	13/3/20
Ireland weighs capital buffer cut as virus spreads- Bloomberg News	13/3/20
CANADA FX DEBT-Canadian dollar rebounds from 4-year low as stimulus hopes rise	13/3/20
US STOCKS-Wall St set to bounce as investors bet on stimulus to thwart recession	13/3/20
Swedish Debt Office says ready to support economy if needed	13/3/20
NY Fed accepts $45.15 bln at overnight repo operation	13/3/20
PRECIOUS-Gold, palladium set for weekly falls after market mayhem	13/3/20
UPDATE 1-U.S. import prices post biggest drop in six months	13/3/20
UPDATE 1-EU to launch 37 bln euro coronavirus investment initiative	13/3/20
German bankruptcies set to rise for first time since 2009 - administrator	13/3/20
RPT-Germany's most populous state to shut schools - n-tv	13/3/20
FACTBOX-The economic remedies for the coronavirus	13/3/20
Germany has shown it is doing a lot to support economy - minister	13/3/20
FOREX-Dollar surges versus Japanese yen as markets rally	13/3/20
NY Fed accepts $24.1 bln at one-month repo operation	13/3/20
Norway suspends airline fees amid virus outbreak, continues talks -finmin	13/3/20
EU ready to facilitate state aid against coronavirus- antitrust chief	13/3/20
Ready to suspend fiscal rules amid virus crisis - EU's Dombrovskis	13/3/20
Germany: Hope coronavirus only causes blip in growth, not crisis of the decade	13/3/20
Germany: No need to take stakes in key companies due to coronavirus at moment	13/3/20
Brazil stock futures point to 9.8% rise at open, real jumps 2%	13/3/20
UPDATE 1-Bank of England sees options to boost UK economy further as coronavirus hits - minutes	13/3/20
US STOCKS-Futures point to recovery after Wall St carnage	13/3/20
EU to set up 37 bln euro coronavirus investment initiative	13/3/20
UPDATE 1-Dollar funding pressures ease as central banks inject liquidity	13/3/20
BoE sees options to boost UK economy further - minutes	13/3/20
NY Fed accepts $17 bln at three-month repo operation	13/3/20
GLOBAL LNG-Asian spot prices rise for second week but linger at seasonal lows	13/3/20
GLOBAL MARKETS-World stocks rise on spending hopes, still set for worst week since 2008	13/3/20
UPDATE 1-Cash-strapped Lebanese banks asked to prioritise FX for coronavirus supplies -statement	13/3/20
Parents want more child care cash as coronavirus shuts schools in Portugal	13/3/20
Norway economy in state of emergency amid virus outbreak -c.bank governor	13/3/20
UPDATE 2-China pumps $79 billion into economy with bank cash reserve cut	13/3/20

Figure 22: Snippet of Market News events that happened on 13 March 2020

Sterling drops to near five-month low on growing coronavirus turmoil	12/3/20
UPDATE 1-United Airlines borrows $2 bln as coronavirus slams industry	12/3/20
GameStop investors seek board seat	12/3/20
GLOBAL MARKETS-Stocks plunge into bear market as Trump's Europe travel ban adds to economic headwinds	12/3/20
CORRECTED-Finland calls for public meetings to be cancelled due to coronavirus	12/3/20
US STOCKS SNAPSHOT-Futures hit down trading limit on Europe travel shock	12/3/20
NY Fed accepts $50 bln at oversubscribed 25-day repo operation	12/3/20
Finland to ban public meetings of more than 500 due to coronavirus	12/3/20
Ukraine central bank cuts main interest rate to 10% from 11%	12/3/20
Brazil central bank announces $2.5 bln spot FX auction for Thursday	12/3/20
UPDATE 1-China to make it easier for firms hit by coronavirus to borrow overseas	12/3/20
UPDATE 1-Merkel's party postpones congress to choose new leader due to coronavirus	12/3/20
UPDATE 1-Mexico must minimize coronavirus economic drag, finance minister says	12/3/20
High-yield default rate could spike to 9.7% in "pessimistic" virus scenario -Moody's	12/3/20
Brazil mulls executive order to release $1 bln to fight coronavirus	12/3/20
UPDATE 1-CEE MARKETS-Stocks plummet; Hungary scraps some bond auctions as coronavirus turmoil escalates	12/3/20
United Airlines raises $2 billion in term loan	12/3/20
UPDATE 2-Bitcoin plummets as cryptocurrencies suffer in market turmoil	12/3/20
Polish president asks banks to allow clients to delay installment payments	12/3/20
Brazil's Caixa Seguridade suspends IPO amid coronavirus concerns	12/3/20
UK scientists not recommending U.S.-style travel ban - PM's spokesman	12/3/20
CORRECTED-TABLE-Holdings of SPDR Gold, iShares Silver drop (March 11)	12/3/20
China to guide regions with low virus risk to speed up work resumption	12/3/20
CANADA STOCKS-TSX futures tumble as oil prices sink	12/3/20
Ukraine's hryvnia slips to 26 vs the dollar for the first time since July 2019	12/3/20
Glass Lewis against call for Kirin buybacks, backs new board nominees	12/3/20
UPDATE 1-Carney sees big challenges as BoE eyes 'digital banknotes'	12/3/20
UPDATE 1-Blackstone says no blanket policy to tap credit lines	12/3/20
US STOCKS-Futures hover at down trading limit after Europe travel shock	12/3/20
EBRD readies emergency measures for virus-stricken firms	12/3/20
Merkel's party postpones congress to choose new leader due to coronavirus	12/3/20
UPDATE 1-Coronavirus could push Ireland into budget deficit, minister says	12/3/20
CORRECTED-TABLE-Holdings of SPDR Gold, iShares Silver drop (March 11)	12/3/20
Intercontinental Exchange closes a London office after coronavirus case	12/3/20
Polish rate-setter says 50 bp rate cut could help virus-hit economy	12/3/20

Figure 23: Snippet of Market News events that happened on 12 March 2020

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Wall Street sell-off batters bitcoin, pounds palladium as investors go to cash	12/3/20
UPDATE 2-Bitcoin plummets as cryptocurrencies suffer in market turmoil	12/3/20
Bitcoin slumps as global market turmoil infects cryptocurrencies	12/3/20

Figure 24: Snippet of Bitcoin related news events that happened on 12 March 2020

It can be observed that bitcoin prices change when industries and sectors that are closely related to bitcoin are hit (Figure 20, Figure 22). Bitcoin prices will then be influenced and possibly suffer a major shock, where the shock is seen in the quick drop in prices. Often, it seems that it takes at least a day for news events to trigger changes in bitcoin's price. Glancing from Figure 21 and Figure 23, it takes news events that happened on 12 March 2020, to cause a major change in bitcoin price on 13 March 2020.

Analyzing the bitcoin related news events that happened on 12 March 2020 (Figure 24), the sharp fall in bitcoin price can possibly be explained by intense market turmoil caused by the Coronavirus pandemic. The pandemic had caused major selling across many of the various asset classes because investors want to minimize their risks from the economic blow brought about by the pandemic. Uncertainty in the stock market and recent regulations that were rolled out worldwide have made investors jittery. Known for its instability and high risk, investors were also unsure of the strength and stability of bitcoin to withstand such market conditions. Thus, many have pulled out from this seemingly high-risk asset in this uncertain time.

4.3 Time Series plots

After performing Time Series Analysis, patterns and trends can be observed from the Time Series plots, and some observations and correlations can be drawn. Visualizing bitcoin prices in the form of a candle stick chart (Figure 25), there is a general upward trend between April 2019 and June 2019. This is followed by a downward trend from June 2019 to December 2019. Following December 2019 till February 2020, there is an upward trend again, before a downward trend followed from February 2020 to March 2020.

Figure 25: Time Series of bitcoin OHLC prices in candlestick chart

Plotting the time series for sentiment score for Business News (Figure 26) and Market News (Figure 27) from 12 April 2019 to 13 March 2020, no obvious trend can be spotted. There seems to be shifting upward and downward trends consistently over the entire period.
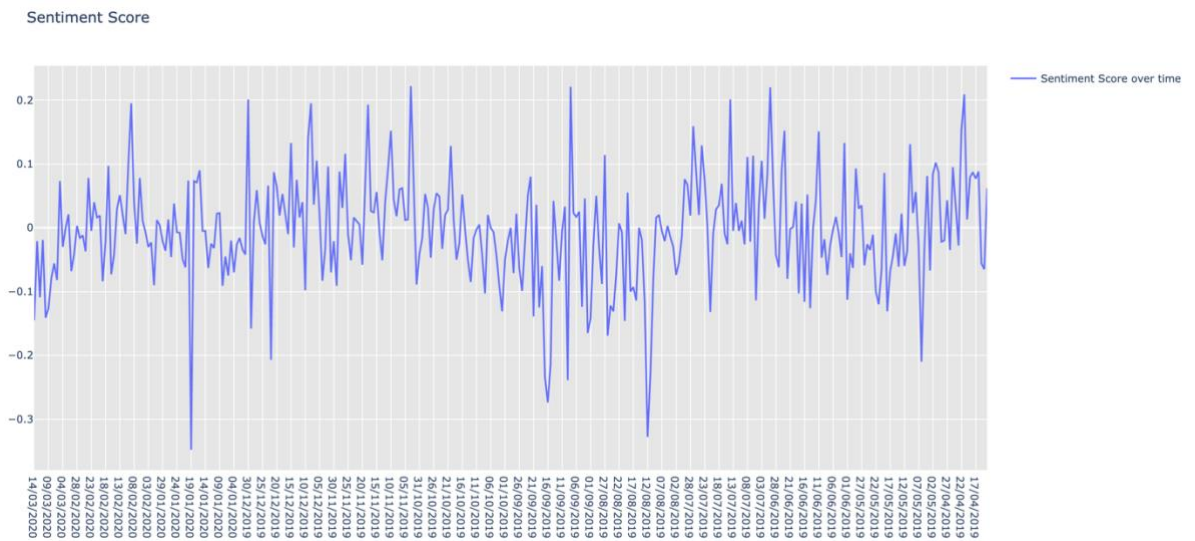
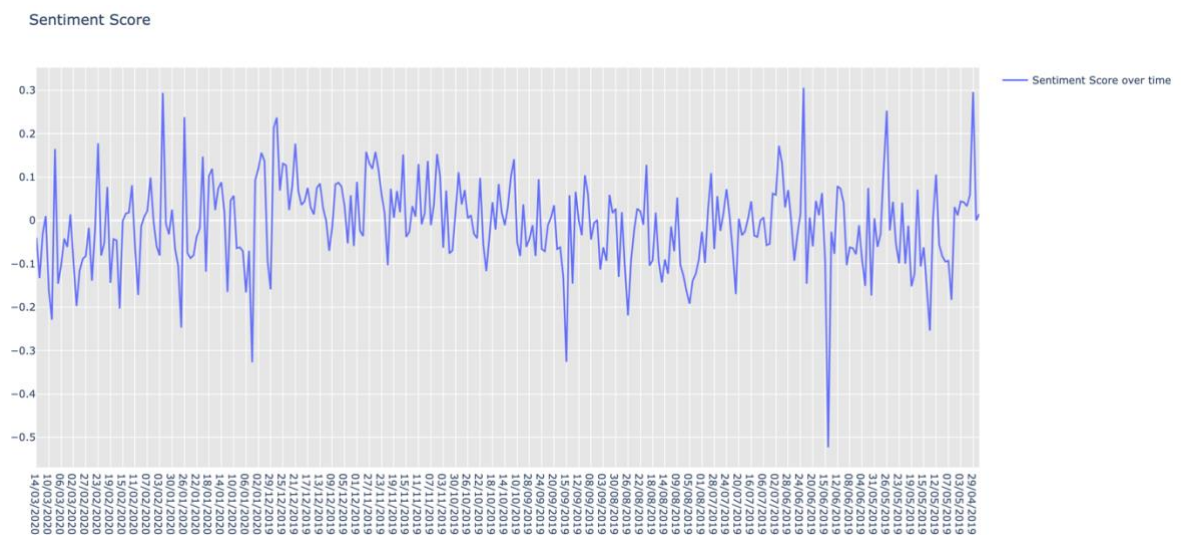Figure 26: Time Series of Sentiment Scores for Business News

Figure 27: Time Series of Sentiment Scores for Market News

When plotting the time series of bitcoin OHLC prices and sentiment scores from 12 April 2019 to 13 March 2020 on the same time series (Figures 28, Figure 29), no distinct correlation can be spotted. Perhaps, it is only when we look at the perspective of a general market situation to determine whether it is looking positive or negative, and thereafter zoom in to specific news, that we can decipher and define a set of distinct scenarios and news events that actually affect bitcoin price.

Figure 28: Time Series of Bitcoin Price vs Sentiment Scores for Business News

Figure 29: Time Series of Bitcoin Price vs Sentiment Scores for Market News

Chapter 5 Conclusion

5.1 Problem Statement revisited

Going back to the problem statement for this project, which was to study the correlation between news events and bitcoin prices and to find out the specific type of news events that directly influences bitcoin prices, we can conclude that sentiments from news events give us an understanding of the general market situation (positive or negative). Different types of news events affect bitcoin prices to different extents, and in varying contexts. Currently, no specific category of news event can be said to impact bitcoin's price to a great extent because no specific correlation can be drawn from the analysis done. However, it can be observed that news events affecting the stability of bitcoin does in fact affect bitcoin prices to the greatest extent. This allows us to draw a link between how "uncertainty" in market situations actually affect bitcoin prices to the highest degree. Therefore, specific news events, which usually are regulatory news or news concerning the general market situation, that indicate a heightened sense of uncertainty in the world markets, usually also create uncertainty in the cryptocurrency market. This subsequently trickles down to impact bitcoin's price.

5.2 Challenges and Limitations

Some of the issues faced in this project include the long hours needed for scraping the news events and large amount of data cleaning required to be performed for news events. As a result of these factors, quite a hefty sum of time were taken.

5.3   Recommendations

Some future improvements that can be made to the project include:

- Specifically source for a related cluster of news events that in effect change bitcoin's price. This might be time consuming, however, it could allow us to see the correlation more clearly since the mass of news events in the background are blurred off.
- Moving on, Autoregressive Integrated Moving Average (ARIMA) could be used to forecast the time series. It can also be extended into Seasonal Autoregressive Integrated Moving Average (SARIMA).

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