Analyzing Trends in Variations of Dow Jones Stocks and Cryptocurrency Prices

Gautam B. Singh
Professor
Oakland University
Rochester, Michigan, USA.

Kabir Singh
Student
Wayne State University
Detroit, Michigan, USA.

Abstract

A cryptocurrency is a digital asset that is designed to work as a medium of exchange where ownership records are stored in a public or private ledger. Blockchain technology is the fundamental technical basis of some of the most common cryptocurrencies, including Bitcoin. Cryptocurrencies, including Bitcoin and Ethereum, have been adopted as a store of value and a conduit for transactions by an increasing number of individuals and financial institutions. As cryptocurrencies have an increased total market capitalization, the potential for cryptocurrencies to impact the traditional equity markets increases. This analysis aims to determine the correlation between the value of Bitcoin and the individual equities present in the Dow Jones Industrial Index.

Keywords

Bitcoin, Ethereum, Cryptocurrency, Crypto-exchanges, Crypto-wallets, Dow Jones Industrial Average, and Correlation-trends Analysis.

1. Cryptocurrencies

A cryptocurrency is a digital or virtual currency that is nearly impossible to counterfeit or double-spend since it's secured by cryptography. Blockchain based decentralized networks create the distributed ledgers that form the backbone of cryptocurrency to ensure the integrity of transactions.

The decentralized structure allows cryptocurrencies to exist outside the control of governments and central authorities. Cryptocurrencies offer considerable security for online transactions since they are safeguarded by techniques such as elliptical curve encryption, public-private symmetric keys, and secure hashing functions. With there being considerable push towards online transactions for large ticket items, cryptocurrencies are primed to be a significant player in corporate business planning and profitability.

Payments are processed with the movement of secure tokens which are managed in a distributed ledger system. Cryptocurrencies offer the advantage of making parties to directly transact business and transfer funds without the need to invoke the services of a trustee like a bank or escrow agencies. Rather, the cryptocurrencies secure transactions through the use of private-public keys. A user is identified by a unique address or a "wallet" that has a public key while the private key is maintained secretly by the wallet owner and used to sign transactions. This allows the transfer of funds to occur between parties without the transaction fees normally charged by the intermediary banks.

2. Bitcoin

Launched in 2009, by an individual under the pseudonym of Satoshi Nakamoto, Bitcoin was the first blockchain-based cryptocurrency. With approximately 20 million Bitcoins in circulation, it is the most popular and valuable cryptocurrency today with an overall capitalization of over USD 1 trillion as of February 2021. There are thousands of alternate cryptocurrencies available today including some that have forked from stable currencies such as Bitcoin and Ethereum. The alternate currencies offer their unique niche and sometimes a target business niche.

3. Cybercurrency Wallets and Exchanges

In this section, we discuss the two key components of the cryptocurrency financial system that essentially make these a viable alternative for a prevalent use in the future.

3.1 Wallets

A cryptocurrency wallet is generally a service or program or can even be a physical device that stores the public and private keys. These keys are necessary to encrypting and initiate transactions and sign smart contracts. Electronically using the keys stored in the wallet legally binding effect and is essentially akin to signing a documentary contract.

From an analogical perspective, the public key of a cryptocurrency owner is like an email identifier, which may be used to retrieve all the transactions of that user has participated in by searching through the blockchain. Thus, the public keys are used to search through and track all the cryptocurrencies transacted by the owner and used to send cryptocurrency to a specific user. In or111der to send

cryptocurrency to a specific recipient, the cryptocurrency owner uses their private key, the transaction is encrypted by the recipient's public key. Thus, the public key is used for sending payments to someone, and the private key is used for spending the cryptocurrency stored in one's own wallet.

In determining how the owner will store their wallet, it must be considered as to who will have access to a copy of the private key. The owner of the private key has the signing authority and thus access to the cryptocurrency. If the private key is located on the web, it will be subject to vulnerabilities of the cyberspace. It is therefore important to review the exchange's policy regarding the storage of an owner's private key.

3.2 Exchanges

The exchanges, as the name implies, are the hub for transacting with cryptocurrency. The exchanges send cryptocurrency to a user's cryptocurrency wallet. An exchange can convert a cryptocurrency into a fiat currency, or sometimes offer the capability of providing ATM cards that work anywhere in the world.

The creators of digital currencies, which are sometimes even backed by fiat capital such as gold or USD, are often independent of the digital currency exchange that essentially focuses on enabling its registered users in transacting cryptocurrency trades.

Some exchanges are traditional brick and mortar businesses, while many are online and use decentralized exchange protocol. Traditional stock market exchange principles are applicable in making cryptocurrency trades. Users place buy and sell orders, limit or market orders, sell long or short, and the exchange makes that possible. It should be noted that the currencies stored in exchanges are not protected by governmental insurance schemes, as are the funds stored in banks which are subject to governmental regulation.

4. Representing Time

Since the valuation of the cryptocurrencies is a time series, a proper representation of time is of critical importance.

4.1 POSIX Time

It's simply the time expressed as the number of seconds that have passed since January 1, 1970. That zero moments, known as the

epoch, is simply the start of the decade in which the Unix operating system (which first used this time representation) was invented. Most of the cryptocurrency exchanges provide this value for the OHLCV (Open, Low, High, Close, and Volume) data being queried.

4.2 CCXT Time

The language Python has gained considerable prominence in the field of financial data analysis and technology, often referred to as FinTech. Most cybercurrency exchanges provide Application Programming Interfaces, or APIs, to directly perform transactions where the users can place trades as well as obtain historical financial information. A prominent language used for designing applications around these APIs is Python since it provides capabilities for performing analysis using competent data structures such as Pandas, visualization libraries such as Matplotlib, powerful statistical munging with NumPy, and the ability to develop machine learning algorithms using the libraries such as Sci-Kit Learn.

A powerful library which has a Python API, in addition to being accessible from many other languages, is the Cyber Currency eXchange Trading (CCXT) library. In addition to allowing for real time trades, the CCXT also offers the capability for retrieving historical trading data.

It will be appreciated that the cryptocurrencies are a brainchild of computers and their ability to make trades within a matter of microseconds. The time slice used in CCXT is therefore much more precise and noted at the micro-second level. The OHLCV data obtained from CCXT has to be rationalized with the data that is obtained from other sources such as Morning Star and Yahoo Finance where the data resolution is accurate to the level of 1 second and based on POSIS timestamp, or Unix Epoch.

5. Data Acquisition and Visualization

As a first step towards building a framework for statistical analysis, the data is downloaded from Yahoo finance, and plotting using the Matplotlib package in Python.
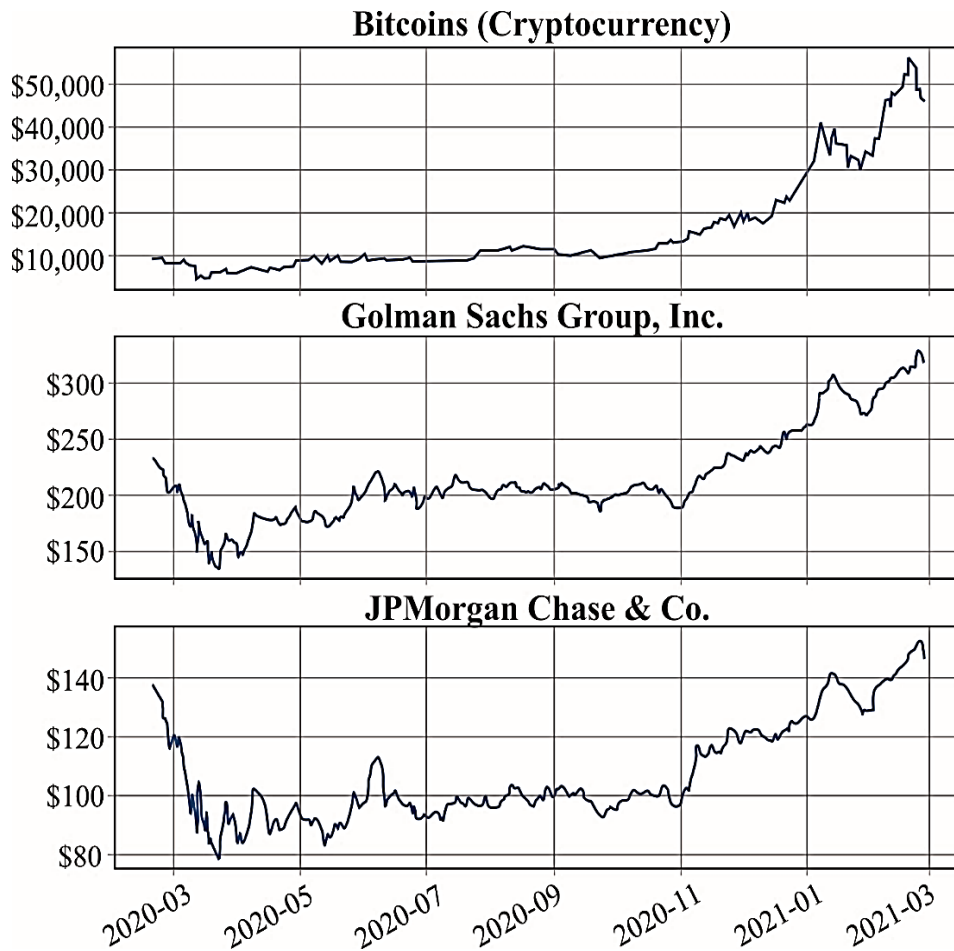
5.1 Cryptocurrency Trends

Figure 1 depicts the growth of two major cryptocurrencies, Bitcoins and Ether, over the period of last 12 months. The trends in both these cryptocurrencies show a similar trend in growth.
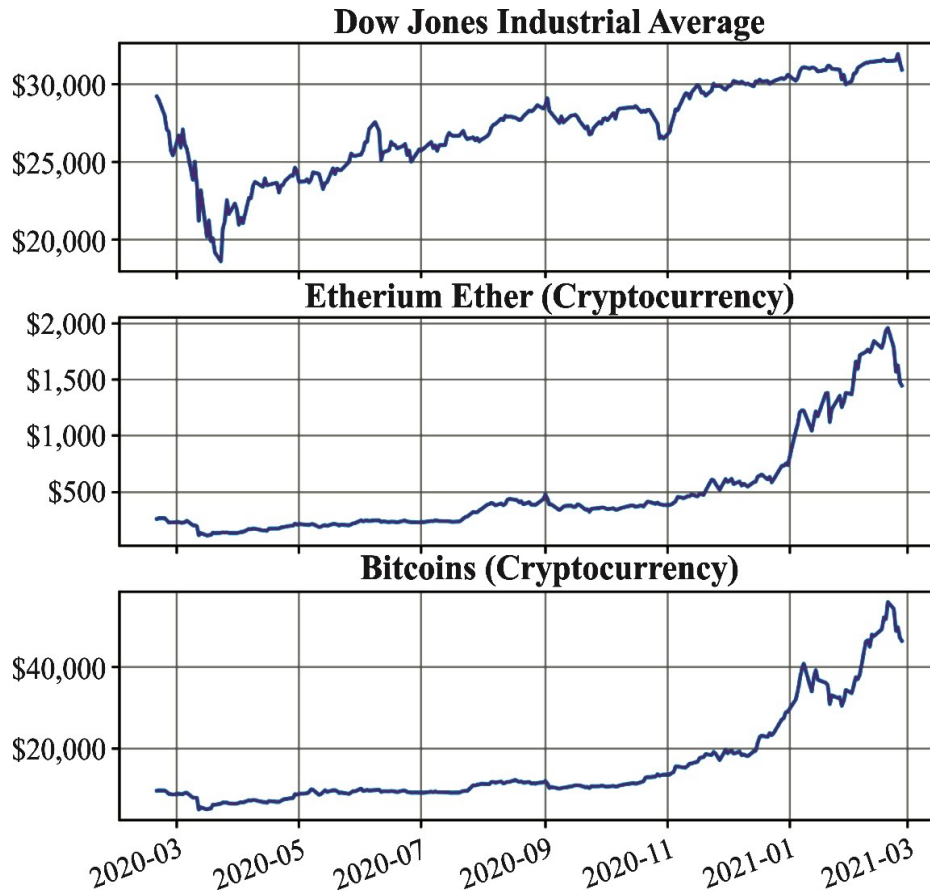
Figure 1: Dow Jones Average and Cryptocurrencies Comparison

## 5.2 Cryptocurrency and Stock Trends

Figure 2 depicts the growth of the Dow Jones Industrial Average (DJIA) which is a composite of the values of stocks computed over 30 stocks covering technology, financial and other sectors, and the Bitcoin cryptocurrency. From the period of February 20, 2020 to February 20, 2021 the cryptocurrency Bitcoin grew by 300 percent while the DJIA appreciated by 15 percent.

Bitcoins (Cryptocurrency)

Golman Sachs Group, Inc.

JPMorgan Chase & Co.

Figure 2: Cryptocurrency and Financial Stock Variations

5.3 Stock Trends

In Fig. 3, the stock prices of two of the 30 components DJIA, namely the technology giant Apple, and pharmaceutical giant Merck.
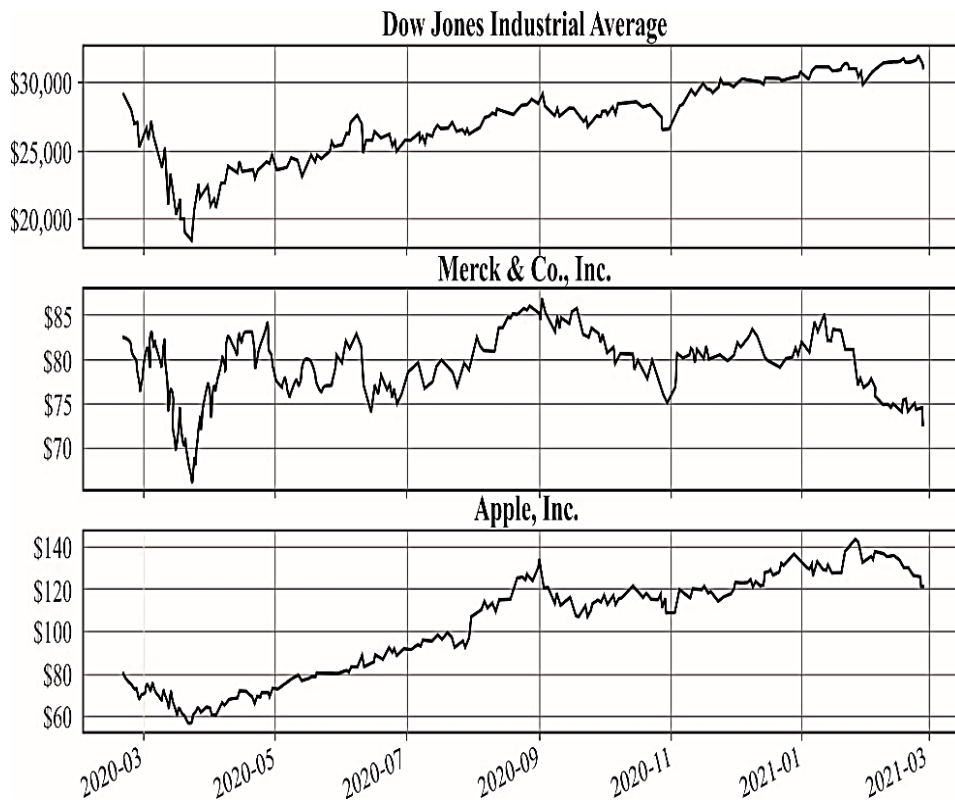
Figure 3: Variations between Dow Jones Average and Two of its Components

As is evident from this illustration, the variation of the stock prices of these two companies is markedly different from each other. Similar trends will be observed if the stock prices for other constituents of DJIA were plotted. The aggregate behavior of DJIA is generally quite different from the behavior of individual stocks.

To see if there is any correlation between the valuation of DJIA and the cryptocurrency, we find that the correlation between DJIA and Bitcoins is approximately 0.75. This is somewhat remarkable since it indicates that the trends in the stock market and Bitcoins were in unison. When the Bitcoins were appreciated, so did the US stock market in general, and vice versa.

The correlation coefficient of the various individual stocks is next computed to determine if any of the individual stocks has a greater correlation with Bitcoins appreciation.

6. Trend Analysis

One of the key issues surrounding cryptocurrency is the lack of knowledge associated with its ups and downs. Investors have gained a level of experience in being able to predict how a specific stock will perform based on how well the company is doing financially, what goals have set for expansion, what product is it introducing into the market, what expensive litigation it might get embroiled in, or the specific governmental regulations are likely to impact its revenue and profit potential. For the most part there is some degree of predictability as investors are owners of a business, and at least to a certain degree, the success of the business enterprise translated into the success of its stock. Predicting the rise and fall of cryptocurrencies on the other hand is not driven by such palpable factors as those that dictate the performance of stocks. It is quite different from the rise and fall of foreign currencies either since those exchange rates are governed by international trade and the strength of a country's economy. Cryptocurrencies have no such surrogate that an investor can look at to make buy or sell decisions.

7. Correlation Results

We examined the relationship of the cryptocurrency with the largest market capitalization, namely the Bitcoin, with the companies that constitute the Dow Jones Industrial Average-a market indicator widely utilized in assessing the relative health of the stock market. The purpose of this study is to see if there is a correlation between any of the stocks and the movements of the Bitcoin pricing.

Our focus for this study is not so much to compare the actual gains of the stocks, but more so to determine if the "trend" of the stock movement is related to the "trend" of the movement of the Bitcoins pricing. If we do find that such a correlation persists, we can begin to explore its causality. Regardless, the trends in the stock price will provide an additional data point to the cryptocurrency investors to perhaps assist them in making somewhat more informed buy or sell decisions.

To estimate these trends, Pearson's correlation coefficient was utilized. It should be noted that while the stock market is closed over the weekend, the cryptocurrency exchanges operate 7 days a week. Therefore, the time series gathered from Yahoo finance for the Bitcoin closing prices had

several more data points when compared to the data points for DJIA stock prices. The two-time series were normalized so that only the data points that were common to both series being compared were used to compute the correlation coefficient using the equation below.

$$r = \frac{\sum_{i=1}^{n}\left(x_1 - \bar{x}\right)\left(y_1 - \bar{y}\right)}{\sqrt{\sum_{i=1}^{n}\left(x_1 - \bar{x}\right)^2}\sqrt{\sum_{i=1}^{n}\left(y_1 - \bar{y}\right)}}$$

Figure 4 presents the results of this correlation between the stock prices and Bitcoin price when viewed over a period of 365 days starting from February 20, 2020 through February 20, 2021. The bar chart illustrates that the stock prices of Goldman Sachs Group, Inc., and investment broker was most strongly correlated with Bitcoin, while companies such as the pharmaceutical giant Merck were negatively correlated.

Table-1 provides the detailed numerical values of the correlation coefficients obtained from this analysis. It is noteworthy that the correlation coefficient of 10 of the 30 stocks used in computing DJIA correlated more with Bitcoins than the remaining 20. This may be an indication that the type of market forces and investor confidence that causes a change in these stocks is perhaps related to the price changes in Bitcoins.

It was also interesting to note that these 10 stocks included companies from various market segments. While two of these top-10 were financial services companies, namely JP Morgan Chase, and American Express, the other companies ranged from insurance businesses like Travelers, to heavy machineries like Caterpillar and everything in between.

It was worth noting was those technology companies like Apple, Microsoft, IBM, Intel or Verizon did not place in this top-10 highly Bitcoin correlated stocks. And the company Pfizer – one of the pioneers of the COVID vaccines also had a relatively low level of correlation of 0.3 with Bitcoin price.

This would indicate that the volatility experienced in Bitcoins is generally not tied to the technology stocks, or stable pharmaceutical stocks, as they are generally more robust to the swings of the market. It's probably worth pointing out that in this trend analysis, our concern was with the direction of movement. The actual appreciations of Bitcoin really dwarfed the gains made by the stock market.
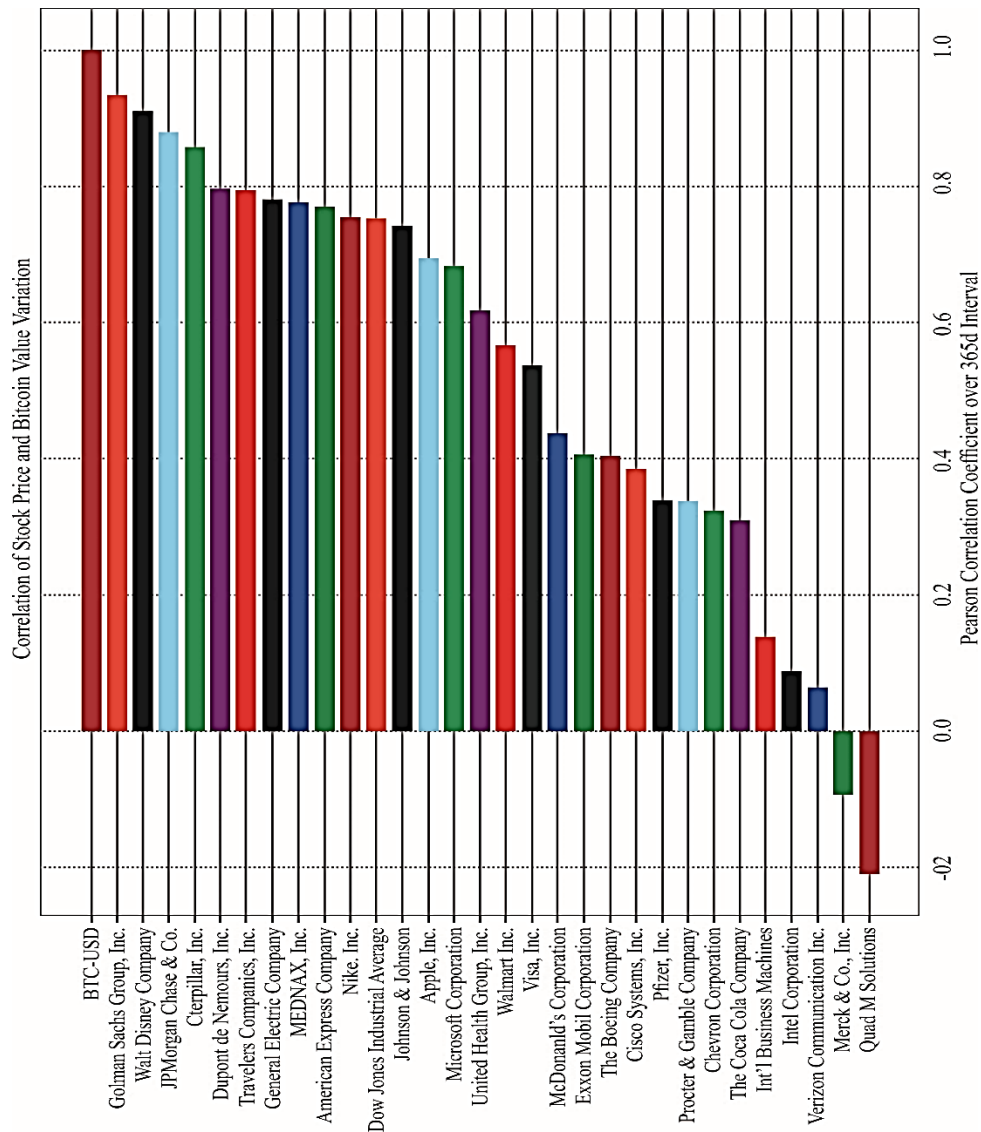

Figure 4: Correlations of DJIA Stocks and Cryptocurrency

8. Correlation or Causality?

Our next objective was to determine if there was perhaps a causal relationship between the highly correlated stocks and the Bitcoin price changes. That is, did the change in the price of one of the correlated stocks had a cascading effect and caused the increase (or decrease) in the Bitcoin prices. To analyze this effect, which we refer to as a causality effect, we moved the Bitcoin time series by plus and five days to see if there was an appreciable gain in the correlation coefficient. Fig. 5 provides the results of this analysis.
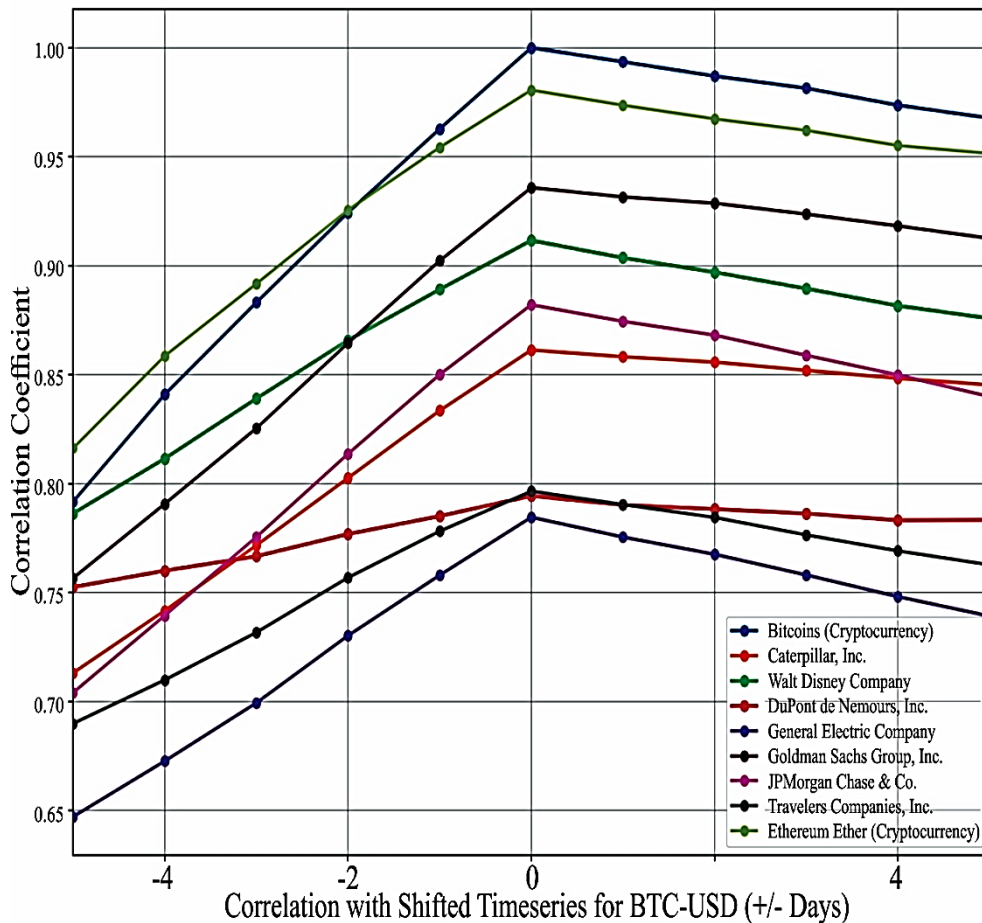

Figure 5: Measuring Correlations with Time Series Shifts

9. Conclusions

This paper provides an overview of issues related to trading volatile cryptocurrencies. The research was focused on determining if there exists a strong correlation between any of DJIA stocks and the prices of the cryptocurrency Bitcoin. We did find a strong correlation with a handful of stocks which indicates the viability of watching these representative stocks as a way for timing an entry and exit strategy for investing in cryptocurrencies. However, a causal link implying that the changes in the price of a stock causes the change in the price of cryptocurrency could not be established.

Table 1: Correlation of DJIA Stocks and Bitcoins over a 1-year Period from February 2020 through February 2021.

	Correlation with Bitcoin Price
Bitcoins (Cryptocurrency)	1.00
Ethereum Ether (Cryptocurrency)	0.98
Goleman Sachs Group, Inc.	0.94
Walt Disney Company	0.91
JPMorgan Chase & Co.	0.88
Caterpillar, Inc.	0.86
Travelers Companies, Inc.	0.80
DuPont de Nemours, Inc.	0.79
General Electric Company	0.78
MEDNAX, Inc.	0.78
American Express Company	0.77
Nike, Inc.	0.75
Dow Jones Industrial Average	0.75
Johnson & Johnson	0.74

Apple, Inc.	0.69
Microsoft Corporation	0.68
United Health Group, Inc.	0.62
Walmart Inc.	0.56
Visa, Inc.	0.54
McDonald's Corporation	0.44
Exxon Mobil Corporation	0.42
The Boeing Company	0.41
Cisco Systems, Inc.	0.39
Chevron Corporation	0.33
Procter & Gamble Company	0.33
Pfizer, Inc.	0.33
The Coca Cola Company	0.30
Int'l Business Machines	0.13
Intel Corporation	0.10
Verizon Communications Inc.	0.05
Merck & Co., Inc.	(0.11)
Quad M Solutions	(0.21)

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