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UNIVERSITY OF NORTH TEXAS

TOULOUSE GRADUATE SCHOOL

MSc in Advanced Data Analytics

The Comparative Analysis of Top 5 Cryptocurrency Returns and Top 5 US Technology Stock Returns for the Period of 2018 to 2024.

May 2024



ABSTRACT

Over the past few years, cryptocurrency and conventional stock prices across the world have experienced consistent increase and surge since the year 2009. This study aims at examining whether there are differences in returns between cryptocurrency and US technology stock for the period of 2018-2024. The historical price data of top 5 major cryptocurrency and top 5 technology stocks in the United States spanning 75 months from January 2018 to April 2024. The historical price data for S&P 500 index was also obtained. The historical price data was used to calculate the returns and cumulative returns for the period. Both the cryptocurrency and stock cumulative returns were used and analysed by using the t-test for two independent samples of unequal variances and regression analysis. Hypothesis testing was conducted in this study to determine whether there is any difference in returns between the selected cryptocurrencies and US technology stocks. Some machine learning algorithms such Linear Regression, KNN Regressor, KNN classifiers and LSTM neural networks for cryptocurrency and stock returns forecasting. In addition, this study documents the investment risks to test whether the β coefficient is greater or less than 1 for both cryptocurrency and technology stocks.

The result shows that there is significant difference in cumulative returns between the selected cryptocurrency and technology stocks in the United States. The result also shows that the β coefficient for the selected cryptocurrency is much higher than the selected technology stocks. These findings imply that investors who are investing in some selected cryptocurrencies would gain higher returns more than the technology stocks, although the risks are higher in some cryptocurrencies due to high price volatility.

INTRODUCTION

In recent years, investment in cryptocurrency market and stock market have become popular across all segments of society. This trend extends beyond individuals with technical expertise in financial markets and many have little or no understanding of investing in stocks and cryptocurrencies. Investors who purchase cryptocurrencies and conventional stocks have the same expectation to gain the highest returns on their investments. This project report focuses on the comparative analysis of the returns of top 5 cryptocurrency and top 5 US technology stocks in terms of market capitalization. The selected cryptocurrency are: Bitcoin (BTC-USD), Ethereum (ETH-USD), Binance Coin (BNB-USD), Cardano (ADA-USD) and Ripple XRP (XRP-USD) and the selected top 5 US technology stocks are Microsoft (MSFT), Apple (AAPL), Amazon(AMZN),Nvidia (NVDA),and Google (GOOG).Through the use of exploratory data analysis (EDA),descriptive statistics, regression analysis, independent t-test, test of hypotheses and machine learning algorithms, we will use data analytics to analyze the data. We will examine the market trend, price movements, and calculate the returns for both cryptocurrency and conventional stocks and then compare the returns. We will also compare the returns difference with the US stock index S&P 500 for the covered period of 2018-2024.

The US technology stocks, when compared with the standard index S&P 500 shows that all the 5 technology stocks have higher returns more than S&P 500, while 3 out of 5 cryptocurrency in this project (*BNB-USD, BTC-USD,ETH-USD*) also have much higher returns than the S&P 500,while the remaining two cryptocurrency(*ADA-USD and XRP-USD*) have lower returns than the S&P 500.Furthermore,there is a very strong correlation between the S&P 500 and the 5 US technology stocks.

The main objective of this report is to determine if the average stock returns differ significantly from the average cryptocurrency returns during the period of January 2018 to April 2024.Considering the fast growing of global cryptocurrency market, it is interesting to know whether the US traditional technology stocks is better to generate higher returns than cryptocurrencies, thus providing the highest profits to the investors.Thus,this study is very crucial to compare the returns of traditional stocks with the cryptocurrency. This project report will test three hypotheses namely: First, to test between the technology stock with the highest returns ***(Nvidia: NVDA)*** and the cryptocurrency with the highest returns ***(Binance Coin: BNB-USD)*** to determine whether there is a difference between their average returns. Secondly, to test between the returns of technology stock with the highest market capitalization ***(Microsoft: MSFT*)** and the cryptocurrency with the highest market capitalization ***(Bitcoin: BTC-USD)*** to check whether there is a difference between their average returns. Lastly, to test between the returns of **S&P500(^GSPC)** and the cryptocurrency with the highest market capitalization ***(Bitcoin: BTC-USD)*** to check whether there is a difference between their average returns.

Furthermore, we will carry out regression analysis and calculate the risk using the β coefficient, finally, we will use machine learning algorithms such as Linear Regression, KNN Regressor, KNN classifiers and LSTM neural networks for cryptocurrency and stock returns forecasting.

This report will provide investors with a broader understanding and insights of investing in cryptocurrency market and US stock market, also to understand the associated risks in cryptocurrencies investment and stocks investment.

LITERATURE REVIEW

Recently, cryptocurrencies market prices and US stock market prices have seen a consistent upward trend since the year 2009 after the global financial crisis in 2008.This literature review delves into the cryptocurrency market and US stock market for the purpose of this project. We will start with a background overview of the cryptocurrency market and US technology stock market. Cryptocurrency is a form of digitalized currency and bitcoin as the pioneering cryptocurrency was launched in 2009 after the 2007-2008 global financial meltdown by anonymous developer under the pseudonym Satoshi Nakamoto and this is the world's first peer-to-peer digital payments platform functioning completely without any central party **(Nakamoto 2008,1)**. After this blockchain innovation of Bitcoin, Bitcoin has continued to attract global attention and has become the most capitalized among over 20000 recognized digital currencies (***with worth about $ 1.25 trillion USD dollars in market capitalization)*** of the global cryptocurrency market capitalization as at today (Coingecko,2024), (Binance,2024).

According to the CoinMarketCap,2024 below are among the top 10 largest cryptocurrencies in the world today in terms of market capitalization:

1. **BITCOIN (BTC-USD):**

With a market cap of $1.25 trillion, Bitcoin (BTC) was created in 2009 by Satoshi Nakamoto and is recognized as the original cryptocurrency (CoinMarketCap,2024). Like other cryptocurrencies, BTC-USD operates on a blockchain, which is a decentralized ledger that records transactions across a network of numerous computers. The security of Bitcoin is ensured through a process known as proof of work, where transactions are verified by solving cryptographic puzzles, thereby protecting it against fraudulent activities (CoinMarketCap,2024)

Bitcoin's popularity has surged over the years, leading to a significant increase in its price. In May 2016, one Bitcoin could be purchased for approximately $500. However, as of April 27, 2024, the price of a single Bitcoin had risen to around $63,629. This remarkable growth represents an astonishing price increase of over 11,166%. (CoinMarketCap,2024).

2. ETHEREUM (ETH-USD)

Ethereum with today's market capitalization of $ 403 Billion USD. Ethereum, which functions both as a cryptocurrency and a blockchain platform, has gained popularity among developers due to its diverse range of potential applications and it allows for the creation of smart contracts, which are self-executing contracts that activate when predetermined conditions are met (CoinMarketCap,2024).Additionally, Ethereum has facilitated the rise of non-fungible tokens (NFTs), which have garnered significant attention in various industries (CoinMarketCap,2024).

According to Binance,2024 and CoinMarketCap,2024, Ethereum has experienced remarkable growth. Between April 2016 and April 2024, its price surged from approximately $11 to around $3,308, representing an astounding price increase of over 29,064%, and this substantial growth has contributed to Ethereum's status as a prominent player in the cryptocurrency market.

3. BINANCE COIN (BNB-USD):

Binance Coin (BNB) with market capitalization of $89 Billion USD is a type of cryptocurrency that serves multiple purposes within the Binance ecosystem, which is one of the largest cryptocurrency exchanges globally was developed as a utility token on the Ethereum network, and it was initially introduced in 2017 primarily for facilitating trades on the Binance exchange platform, Binance Coin has since expanded its utility and it can now be utilized for various purposes, including trading, payment processing, and even making travel arrangements

(CoinMarket,2024, Binance,2024). Additionally, BNB can be exchanged or traded for other cryptocurrencies such as Ethereum or Bitcoin in various cryptocurrency exchanges.

During its initial release in 2017, BNB was priced at a mere $0.10, however, as of late April 2024, the price of BNB had surged to approximately $606, resulting in an exceptional price gain of over 600,000 %, and this impressive increase in value highlights the growing prominence and success of Binance Coin within the cryptocurrency market (CoinMarketCap,2024).

4. **RIPPLE XRP (XRP-USD):**

XRP, a cryptocurrency with market capitalization of $ 28.5 Billion USD was created by the founders of Ripple, a digital technology and payment processing company that operates on the Ripple network to enable the seamless exchange of various currency types, including fiat currencies and other prominent cryptocurrencies (CoinMarketCap,2024). At the start of 2017, the price of XRP stood at $0.006, however, as of April 27, 2024, the price had surged to $0.56, representing an impressive increase of 9,254% and this substantial growth underscores the growing recognition and adoption of XRP within the global cryptocurrency market (CoinMarketCap,2024).

5.**CARDANO (ADA-USD):**

With a market cap of $16.8 billion, Cardano (ADA) entered the cryptocurrency scene slightly later than some of its counterparts like Ethereum, however, it has gained recognition for its early adoption of proof-of-stake validation, a method that enhances transaction speed and reduces energy consumption and environmental impact (CoinMarketCap,2024).Cardano also operates similarly to Ethereum and enables the execution of smart contracts and decentralized applications that are all powered by its native coin, ADA,in addition, in terms of price growth,

ADA has experienced relatively modest gains compared to other major cryptocurrencies. In 2017, ADA was valued at $0.02. As of April 27, 2024, its price stood at $0.50, reflecting a price increase of about 2,800% (CoinMarketCap,2024).

For this study, the following top 5 US technology companies' stocks were selected, and they are:

1. MICROSOFT CORPORATION (MSFT)

Microsoft Corporation is a US technology company with market capitalization of $ 3.109 trillion USD. At the start of 2014, the price of MSFT stood at $35, however, as of April 27, 2024, the price had surged to $406, representing an impressive increase of 1,197% and this substantial growth underscores the reputation of Microsoft as the most capitalized company in the globe (Yahoo Finance,2024).

2. **APPLE INC (AAPL)**

Apple Inc is a US technology company with market capitalization of $ 2.614 trillion USD. At the start of January 2018, the price of AAPL stood at $40.67, however, as of April 27, 2024, the price had surged to $169.30 after stock splits, representing an impressive price increase of 322% (Yahoo Finance,2024).

3. **NVIDIA (NVDA)**

NVIDIA is a US technology company with market capitalization of $ 2.193 trillion USD. At the start of January 2018, the price of NVDA stood at $49.31, however, as of April 27, 2024, the price had surged to $877.35, representing an impressive increase of 1678% (Yahoo Finance,2024).

4. **ALPHABET GOOGLE (GOOG)**

Alphabet Google is a US technology company with market capitalization of $2.144 trillion USD. At the start of January 2018, the price of GOOG stood at $53.25, however, as of April 27, 2024, the price had surged to $173.69, representing an impressive increase of 226.42% (Yahoo Finance,2024).

5. **AMAZON (AMZN)**

Amazon Inc is a US technology company with market capitalization of $1.868 trillion USD. At the start of January 2018, the price of AMZN stood at $59.45, however, as of April 27, 2024, the price had surged to $179.62, representing an impressive increase of 202% (Yahoo Finance,2024).

PURPOSE

The purpose of this report is to compare the returns from US technology stocks and the returns from cryptocurrencies during the period of January 2018 to April 2024. For this project, we will use the adjusted close price to calculate the stock returns and cryptocurrency returns. The project will address this hypothesis by carrying out a statistical independent t-test of means to determine if the average stock returns differ significantly from the average cryptocurrency returns during the period of January 2018 to April 2024. We will also carry out regression analysis and calculate the risk using the β coefficient, finally, we will use machine learning algorithms such as Linear Regression, KNN Regressor, KNN classifiers and LSTM neural networks for cryptocurrency and stock returns forecasting.

METHODOLOGY:

75 historical data points(months) or observations each from US technology stocks: MSFT, AAPL, GOOG, NVDA, AMZN, ^GSPC (S&P 500) and cryptocurrency: BTC-USD, ETH-USD, BNB-USD, XRP-USD, ADA-USD were collected and analyzed. The historical price data were obtained from Yahoo Finance API for a selection of major cryptocurrencies, major US technology stocks and stock market index (S&P 500). The data were cleaned and preprocessed to ensure data consistency. The returns and cumulative returns for both cryptocurrencies and the stocks were calculated. Various statistical analyses including the standard deviation, mean, and median for both cryptocurrencies and stocks were calculated.

The project will use Python programming language for data analytics and data visualization. The following Python libraries will be used:

- Pandas: For data manipulation.
- NumPy: For numerical computations and mathematical operations
- SciPy and Statsmodels: For statistical analyses, including hypothesis testing.
- Matplotlib and Seaborn: For data visualization, including the plots, charts etc.
- Machine learning algorithms such as Linear Regression, KNN Regressor, KNN classifiers and LSTM neural networks for cryptocurrency and stock returns forecasting.
- Regression models to determine the most risker investment between cryptocurrencies and stocks.
- Evaluate the performance of the models using metrics such as RMSE, MAE, accuracy score and R-squared.

Description of Dataset 1: The description of dataset of 5 major cryptocurrency with 6 variables for each cryptocurrency (total of 30 variables) are shown below:

- Bitcoin (BTC-USD) ticker for Bitcoin and US dollar Exchange rate
- Ethereum (ETH-USD) ticker for Ethereum and US dollar Exchange rate
- Binance coin (BNB-USD) ticker for Binance coin and US dollar Exchange rate
- Cardano (ADA-USD) ticker for Cardano and US dollar Exchange rate
- Ripple XRP (XRP-USD) ticker for XRP and US dollar Exchange rate

Description of Dataset 2: The dataset of 5 major US Technology stocks and the S&P500 index with 6 variables for each stock (total of 30 variables) as listed on the floor of New York Stock Exchange (NYSE).

- Apple Inc. (AAPL) ticker
- Amazon.com Inc (AMZN) ticker
- Alphabet Inc. Google (GOOG) ticker
- Microsoft Corp. (MSFT) ticker
- Nvidia Corp (NVDA) ticker
- S&P500 Market Index (^GSPC) ticker
- Open: This is the daily opening price for each stock or cryptocurrency
- Close: This is the daily closing price for each stock or cryptocurrency
- High: This is the daily highest price for each stock or cryptocurrency
- Low: This is the daily lowest stock for each stock or cryptocurrency
- Volume: This is the stock volume traded daily for each stock or cryptocurrency
- **Adj Close**: This is daily stock adjusted closing price after-market hours with respect to other stock attributes such as dividends, stock splits and new stock offerings for each stock.

LIMITATIONS OF THE PROJECT:

- There is no regulated or cryptocurrency benchmark market index like S&P 500 to compare the individual cryptocurrency returns. For this project, we will use Bitcoin (BTC-USD) as the benchmark to compare other cryptocurrencies returns since it is the most capitalized cryptocurrency.
- Traditional stocks are traded only 5 days a week excluding public holidays while cryptocurrencies are traded 365 days a year and 7 days a week including holidays therefore the data for the study period is not balanced.

TYPE OF TESTS:

All the tests of hypothesis for the stocks and cryptocurrencies have the population parameter as the average return from 75 months historical data points. The hypothesis test will determine if there is any significant difference in the stock returns and the cryptocurrency returns. To perform this two-tailed t-test will be used.

TWO-TAIL TEST HYPOTHESIS:

The two-tail hypothesis test will determine if the average stock returns is different from the average cryptocurrency returns for the period of the study. We selected NVDA stock and BNB-USD for the test of hypothesis because they have the highest stock returns, and the highest cryptocurrency returns respectively for the period of 2018-2024.The null hypothesis is the average return of the selected traditional stock ***(NVDA)*** is equal to the average return of the selected cryptocurrency ***(BNB-USD).*** The alternative hypothesis is the average return of the selected traditional stock (***NVDA***) is not equal to the average return of the selected

cryptocurrency ***(BNB-USD)***. We will use the two independent samples t-statistics test for unequal variances. We will use 95% confidence level; therefore, the significance level is 0.05. The test of hypothesis together with the confidence interval will provide us with enough evidence to reject or fail to reject the hypothesis.

1ST HYPOTHESIS:

H0: μNVDA - μBNB-USD = 0 (Null Hypothesis)

HA: μNVDA - μBNB-USD ≠ 0 (Alternate Hypothesis)

Where μNVDA is the average of the stock returns and μBNB-USD is the average of the cryptocurrency returns.

2ND HYPOTHESIS:

The 2nd hypothesis test will be between the technology stock with the highest market capitalization [MSFT] and the cryptocurrency with the highest market capitalization [BTC-USD] to check whether there is a difference between the average stock returns and average cryptocurrency returns.

H0: μMSFT - μBTC-USD = 0 (Null Hypothesis)

HA: μMSFT- μBTC-USD ≠ 0 (Alternate Hypothesis)

3RD HYPOTHESIS:

The 3rd hypothesis tests between the stock index S&P 500 (GSPC) and using Bitcoin [BTC-USD] as cryptocurrency index to check whether there is a difference between the average stock returns and average cryptocurrency returns.

H0: μS&P500 - μBTC-USD = 0(Null Hypothesis)

HA: μS&P500 - μBTC-USD ≠ 0 (Alternate Hypothesis)

It was observed from our analysis that the average stock returns are not the same as the average cryptocurrency returns throughout the entire period and we reject all null hypothesis because there is significant difference between cryptocurrency and stock returns. The p-value is 0.0000 which is less than $\alpha = 0.05$.

EXPLORATORY DATA ANALYSIS (EDA):

The following tables give the descriptive statistics or summary statistics of the cryptocurrencies and US technology stocks datasets.

```
In [97]: #The descriptive statistics of the Close Price of cryptocurrency
         df_crypto.describe()
```

Out[97]:

cryptoDetails	ADA-USD	BNB-USD	BTC-USD	ETH-USD	XRP-USD
count	2304.000000	2304.000000	2304.000000	2304.000000	2304.000000
mean	0.478731	183.037266	23443.711406	1340.220911	0.523778
std	0.565784	180.870197	17467.944225	1166.029120	0.321465
min	0.023961	4.530000	3236.760000	84.310000	0.139635
25%	0.082155	16.400000	8597.940000	234.370000	0.310446
50%	0.292069	207.440000	19155.840000	1216.250000	0.453622
75%	0.574370	310.777500	36588.445000	1971.355000	0.624419
max	2.968239	675.680000	73083.500000	4812.090000	3.377810

```
In [96]: #The descriptive statistics of the Close Price of technology stocks and S&P 500 (^GSPC)
         df_stock.describe()
```

Out[96]:

stockDetails	AAPL	AMZN	GOOG	MSFT	NVDA	^GSPC
count	1586.000000	1586.000000	1586.000000	1586.000000	1586.000000	1586.000000
mean	112.126040	122.503001	94.228644	218.301740	186.255069	3657.448462
std	52.360532	34.412758	33.316519	92.516904	177.770290	742.350355
min	34.080000	59.450000	48.810000	79.210000	31.520000	2237.400000
25%	52.652500	91.122500	60.272500	130.652500	60.137500	2904.477500
50%	124.890000	118.390000	91.135000	225.820000	133.730000	3772.205000
75%	157.545000	156.902500	126.067500	287.300000	229.347500	4298.520000
max	197.860000	189.050000	160.790000	429.370000	950.020000	5254.350000

Table 1: Shows the summary/descriptive statistics for the adjusted close price of cryptocurrencies (***top***) and US technology stocks (***below***).

The Exploratory Data Analysis (EDA) shows that the US technology stocks and cryptocurrencies are positively skewed to the right, (***See fig. 1 & 2, fig.3 & 4***), while S&P 500 (GSPC) suggests a slight right and positive skewness which means that the tail of the distribution extends more towards the right side with higher values than the left side with lower values. This indicates that there are few relatively larger values in the dataset which makes the distribution to be slightly skewed to the right. The S&P500(GSPC) shows a relatively small deviation from perfect symmetry which suggests a slight right positive skewness. The mean price, standard error, median, standard deviation, and other descriptive statistics of the US technology stocks, and major cryptocurrencies are all shown above (***See Table 1 above***).

Generally, the trends for both the US technology stocks and cryptocurrencies are relatively similar with upward price movement patterns and trends from year 2018 to 2024 ***(See fig. 5 & 6).*** Although, for the US technology stocks, the S&P 500(GSPC) is at the top due to the high price difference between the S&P index and other stocks. For cryptocurrency, Bitcoin (BTC-USD) also dominates and it's at the top of the chart due to the high price difference between Bitcoin and other major cryptocurrencies. Bitcoin adjusted close price has a much more pronounced price difference when compared to the rest of the major cryptocurrencies, causing a major discrepancy.

STOCKS AND CRYPTOCURRENCIES RETURNS:

The adjusted close price from the datasets was used to compute the daily returns and cumulative returns for both the US technology stocks and the major cryptocurrencies. The computed cumulative returns are shown below:

] :

cryptoDetails Date	ADA-USD	BNB-USD	BTC-USD	ETH-USD	XRP-USD
2018-01-02	0.074013	0.051130	0.097011	0.144699	0.037586
2018-01-03	0.481712	0.134364	0.113039	0.246014	0.298758
2018-01-04	0.529005	0.095125	0.142196	0.269569	0.336926
2018-01-05	0.371783	0.774078	0.276213	0.291313	0.275061
2018-01-06	0.409648	1.706302	0.283352	0.348209	0.293990
...	...	...	...	...	...
2024-04-18	-0.371249	64.656361	3.650496	2.968252	-0.789638
2024-04-19	-0.356647	64.979786	3.674719	2.959515	-0.789302
2024-04-20	-0.305698	66.890606	3.758987	3.086806	-0.778634
2024-04-21	-0.314778	67.920333	3.754023	3.073424	-0.780563
2024-04-22	-0.290633	71.007134	3.893952	3.143780	-0.767116

Table 2: Shows the cumulative cryptocurrency returns for the entire period.

stockDetails Date	AAPL	AMZN	GOOG	MSFT	NVDA	^GSPC
2018-01-03	-0.000246	0.012784	0.016338	0.004620	0.065910	0.006399
2018-01-04	0.004426	0.017325	0.020094	0.013487	0.071385	0.010453
2018-01-05	0.015982	0.033810	0.034930	0.026099	0.080511	0.017561
2018-01-08	0.012048	0.048612	0.039437	0.027098	0.113567	0.019252
2018-01-09	0.012048	0.053490	0.038685	0.026474	0.113364	0.020580
...	...	...	...	...	...	...
2024-04-16	3.164741	2.083600	1.929577	4.177073	16.727641	0.873800
2024-04-17	3.130809	2.049285	1.946103	4.142857	16.042182	0.862969
2024-04-18	3.107204	2.014634	1.956995	4.048327	16.171162	0.858855
2024-04-19	3.057045	1.937426	1.924319	3.984016	14.453255	0.842574
2024-04-22	3.077699	1.981161	1.966197	4.006993	15.126141	0.858662

Table 3: Shows the cumulative stock returns for the entire period.

stockDetails	AAPL	AMZN	GOOG	MSFT	NVDA	^GSPC
count	1585.000000	1585.000000	1585.000000	1585.000000	1585.000000	1585.000000
mean	1.758080	1.061275	0.770038	1.727135	2.778979	0.356941
std	1.287098	0.578421	0.625561	1.154856	3.605619	0.275313
min	-0.162036	0.012784	-0.083380	-0.010864	-0.360779	-0.170045
25%	0.295550	0.532885	0.132019	0.631993	0.220645	0.077591
50%	2.070814	0.991590	0.712676	1.820180	1.712229	0.399898
75%	2.874109	1.639361	1.367700	2.588786	3.653012	0.594645
max	3.865011	2.179983	2.019531	4.361763	18.266275	0.949080

```
cumCryptoReturns.describe()

#cumCryptoReturns.to_csv('CummulativeCryptoReturns.csv')
```

cryptoDetails	ADA-USD	BNB-USD	BTC-USD	ETH-USD	XRP-USD
count	2303.000000	2303.000000	2303.000000	2303.000000	2303.000000
mean	-0.343145	20.773257	0.716894	0.734918	-0.781280
std	0.776611	21.506878	1.279219	1.509399	0.133486
min	-0.967116	-0.461356	-0.763000	-0.890881	-0.941600
25%	-0.887278	0.951249	-0.370473	-0.696728	-0.870196
50%	-0.599187	23.765755	0.402736	0.574990	-0.810287
75%	-0.213969	35.960166	1.679260	1.551809	-0.738965
max	3.073575	79.342449	4.351280	5.228114	0.412701

Table 4: Shows the descriptive or the summary statistics of stock returns ***(top)*** and cryptocurrency returns ***(below)*** for the entire period.

REPORT:

The cumulative return for the cryptocurrency shows that Binance coin (BNB-USD) has the highest returns of **7,100%** for the entire period followed by Bitcoin (BTC-USD) **389%**, then Ethereum (ETH-USD) **314%** while Cardano (ADA-USD) and Ripple XRP(XRP-USD) returns decreased by -**29%** and -**77%** respectively. The cumulative returns for the US technology stocks shows that Nvidia (NVDA) has the highest returns of **1,512 %** for the entire period followed by Microsoft (MSFT) **400%**, then Apple Inc (AAPL) **307%** while Amazon (AMZN) and Google (GOOG) returns are **198%** and **197%** respectively. The S&P500 (^GSPC) has cumulative return of **86%** for the entire period which is lower than the US technology stocks.

The descriptive statistics for major cryptocurrencies returns and US technology returns are shown above in ***Table 4 above.*** Generally, the returns growth rates for the cryptocurrency BNB-USD appears to be the most elastic with a standard deviation of **21.5** followed by NVDA stock with standard deviation of **3.60**, meaning that they both fluctuate to a higher degree than the S&P 500(^GSPC) returns, the standard deviation of S&P 500 is **0.28**. From the descriptive statistics, it shows that the cryptocurrency BNB-USD is the most volatile cryptocurrency throughout the period while NVDA is the most volatile stock for the period. For the cryptocurrency, XRP-USD and ADA-USD witnessed the highest decline of -**77%** and **-29%** respectively.

STOCKS & CRYPTOCURRENCIES RETURNS CORRELATION COEFFICIENTS

The correlation coefficients shows that all the US technology stocks returns show strong to very strong positive correlation coefficients. The highest correlation of 0.98 is between GOOG and S&P500, followed by MSFT and S&P500 with 0.97. The strong to very correlation between the

REPORT:

It is crucial to test our hypotheses, and not just make assumptions based on exploratory data analysis. The p-value and test-statistic were obtained using t-test for two-sample assuming unequal variances for the entire period as shown above in ***Figure 11,12,13***. We used the level of significance as (α) = **0.05.** The following test of hypotheses as stated above in (***Fig.11,12 & 13)*** were used. In our test of hypothesis, we want to see if the returns for cryptocurrency and returns for stocks are the same throughout the period.

From our Python data file and results above, the t-stat in each hypothesis test falls very far from the critical value of the two-tailed test and all the p-values are less the significant level. As a result, we reject all three null hypotheses, and conclude that the average cryptocurrency returns are not the same as the average stock returns, and there is a significant difference between the cryptocurrency returns and stock returns.

REGRESSION ANALYSIS

To compare the investment risk β for cryptocurrency returns and stock returns, since there is no cryptocurrency benchmark market like S&P500 index, therefore for this project we can only compare the stock returns with S&P 500 returns, also cryptocurrencies are traded 365 days/year and 7 days a week including holidays while stocks are traded only 5 days a week excluding public holidays. It is difficult to compare directly between cryptocurrency returns and stock returns because they are not traded on the same day throughout the period.

For this project, we used the following methods to calculate the risk.

- We used the standard deviation of the cumulative returns of cryptocurrencies and stocks.
- We compared the stock market index S&P 500 and the stock with the highest return (NVDA) and extrapolated the risk (beta) to compare with the cryptocurrencies returns.
- We used the Bitcoin (BTC-USD) returns as the benchmark to compare other cryptocurrencies returns since Bitcoin is the most capitalized and most dominant cryptocurrency and then extrapolated the risk(beta) to compare with the stock returns.

The standard deviations ***(see Table 4)*** shows that BNB-USD cryptocurrency has the highest standard deviation of 21.5 followed by NVDA with standard deviation of 3.60 for the period. This suggests that the cryptocurrency (BNB-USD) has the highest volatility and the highest returns of 7100% when compared with other cryptocurrencies returns and stock returns.

REPORT:

The regression equations for the stock return change for each stock relative to the S&P 500 return is shown below:

$$ri = \alpha + \beta\, r\text{SP500}$$

where ri is the returns for each technology stock

rSP500 is the returns of S&P 500 index.

The regression model equations are as follows:

1. rNVDA = α + β rSP500

   rNVDA = α + 10.73 * rSP500

   The slope β is **10.73**, it means that any one-unit change or 1% change in S&P 500 index returns then NVDA stock is expected to change by 10.73%. Since β is greater than 1, it means that NVDA is riskier than the S&P 500 index.

The regression equations for the cryptocurrency return change for each cryptocurrency relative to the Bitcoin (BTC-USD) return is shown below:

$$ri = \alpha + \beta\, r\text{BTC-USD}$$

where ri is the returns for each cryptocurrency

rBTC-USD is the returns of Bitcoin.

The regression model equations are as follows:

2. rBNB-USD = α + β rBTC-USD

   rBNB-USD = α + 14.97 * rBTC-USD

The slope β is **14.97**, it means that any one-unit change or 1% change in Bitcoin (BTC-USD) returns then Binance coin (BNB-USD) is expected to change by 14.97%. Since β is greater than 1, it means that BNB-USD is more aggressive or riskier than Bitcoin (BTC-USD).

From the two regression models, cryptocurrency (BNB-USD) has the highest **β of 14.97** which is as result of high price volatility or fluctuations and elastic nature of BNB-USD cryptocurrency return and it is the riskiest and the most aggressive among all the cryptocurrencies and technology stocks evaluated in this project.

MACHINE LEARNING ALGORITHMS

Machine learning algorithms such as Linear Regression, KNN Regressor, KNN classifiers and LSTM neural networks for cryptocurrency and stock returns forecasting were used to predict the stock returns and cryptocurrency returns. We normalize or scale the data within a specific range to avoid those features with large values from interfering with the model and to avoid bias. Normalization will help the model to achieve rapid convergence in the prediction or forecasting. In some models, we were able to predict the adjusted close price and then used the Python function pct_change () to calculate the returns from the predicted values.

Linear Regression

Linear regression was used to understand the relationship between a dependent variable (NVDA) returns and independent variable S&P 500 (^GSPC) returns. We used S&P 500

because it is widely used by investors, traders, and financial professionals as a benchmark to assess the performance of U.S stocks and it helps to build investment portfolios.

The S&P 500 stock market index which is used to measure the stock performance of 500 large publicly traded companies in the United States. It gives a comprehensive view of the US equity market and is regarded as a benchmark to assess the overall performance of the US stock market. The Linear Regression for the stock with the highest returns (NVDA) and S&P 500 (^GSPC) returns is shown below.

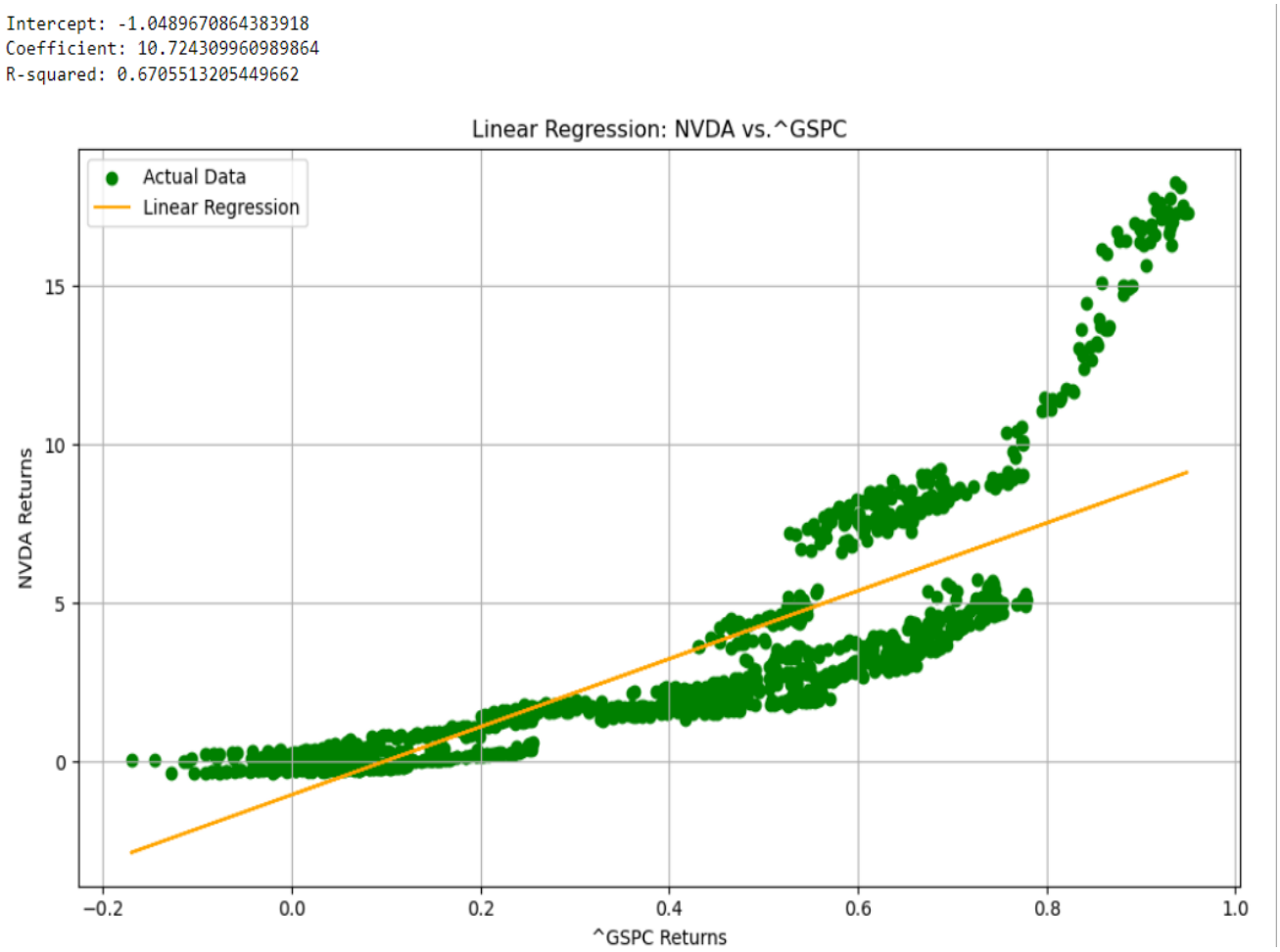

Figure 16: Shows the linear regression model for NVDA returns and S&P 500 returns.

Let's consider a linear regression model with one independent variable:

$$y = \beta_0 + \beta_1 x_1 + \varepsilon$$

where y = NVDA stock returns, β_0 is the intercept = -1.05, **β (beta)** is the slope = **10.724**, x = ^GSPC (S&P 500) returns, ε is the error factor and calculated R-Squared = 0.67055

$y = -1.05 + 10.724\ x_1 + \varepsilon$

The equation means that when S&P 500 is zero, the predicted value (NVDA) is -1.05 and coefficient value of 10.724 indicates that for one-unit increase in S&P 500 returns then the value of NVDA returns will increase by approximately 10.724.The R-squared of 0.67055 is an indication of goodness-of-fit of the linear regression model and suggests that 67.05% of the variability in NVDA returns can be explained by the linear relationship with S&P 500,while the remaining 32.95% is unexplained or attributed to other factors not included in the model.

K-Nearest Neighbors Regressor and K-Nearest Neighbors Classifier

KNN regressor and KNN classifiers were used for prediction and classification respectively especially for calculations of the Euclidean distances between data points. The details are shown in the attached Python codes and outputs.

Neural Networks LSTM for forecast of NVDA returns and BNB returns.

The Neural Networks LSTM was also used to predict or forecast the future trends of the stock and cryptocurrency returns for 100 days. The LSTM model was built, trained, and tested on time series data of stock returns and cryptocurrency returns and the model was able to predict the next returns. The model was trained by 100 epochs to predict the returns for the next 100 days. The LSTM neural network model performance was evaluated once in 100 epochs for both training and test data. At the beginning of the training, the training loss was high, but it dropped significantly as the training progresses, and the reduction in training loss shows that the model

Conclusion

In conclusion, this report introduced the background of the five major cryptocurrencies and five major US technology stocks, also discussed the price trends and movement since year 2009 after the global economic recession of 2008. The cryptocurrencies prices and returns fluctuate to a higher degree than stocks while BNB-USD cryptocurrency returns and NVDA stock returns are very hot, fluctuating to a higher degree and more elastic than other major cryptocurrencies and stocks. It was observed from our analysis that the average returns in cryptocurrency (BNB-USD) is not the same as the average returns in stock (NVDA) therefore we reject the null hypotheses. Some of these stocks such as NVDA will continue to experience an upward movement in returns because of high profitability as per our neural network LSTM forecast, although our LSTM forecast shows that cryptocurrency BNB-USD returns will dip downwards in the next 100 days forecasting.

From our regression analysis, it was observed that the cryptocurrency (BNB-USD) has the highest returns of **7100%** , highest risk with $\boldsymbol{\beta}$ **of 14.97** and highest standard deviation of **21.5** while for US stocks NVDA has the highest returns of **1512%** , highest risk with $\boldsymbol{\beta}$ **of 10.73** which shows high price volatility and fluctuations, and cryptocurrencies (BNB-USD) is the most aggressive and the riskiest among all the major cryptocurrencies and all the major stocks for this project. Although one of the cryptocurrencies (BNB-USD) has the highest returns, it is very important for investors to be very cautious when investing in cryptocurrencies because 2 out of 5 cryptocurrencies for this project experienced a downward trend of **- 29%** and **-77%** for Cardano (ADA-USD) and Ripple (XRP-USD) respectively. The 5 major US technology stocks all showed an upward return of 1512%,400%,307%,198%,197% for NVDA, MSFT, AAPL,