Executive Summary
The Impact of Macroeconomic Factors
on Bitcoin Price

Kiet Nguyen
ID: 001601720
kngu179@wgu.edu

Problem Statement

Bitcoin is an extremely volatile asset class. Its value went from $0 in 2009 to an all-time-high of $69,000 in 2021. It has since stumbled back down to $20,000 in early of September 2022. While there had been enormous interest and capital being funneled into Bitcoin, there had been much less empirical studies on it. Its short history meant a lack of long-term data to determine its relationship to the financial market. An important question about Bitcoin was that whether macroeconomic factors, such as the dollar strength, interest rates, inflation, and unemployment, influenced its price? Knowing the answer to this question would determine if Bitcoin followed the same cycle as the overall economy.

Hypothesis

H_0: Bitcoin price is not affected by macroeconomic factors
H_1: Bitcoin price is affected by macroeconomic factors

Analysis Process

The datasets were first collected from government agencies and analytics company. Each dataset was cleaned individually due to different time ranges. The closing prices for Bitcoin only went back to July 2014. Economic datasets went back much further, with inflation rate as far back as 1914. Older data had to be dropped from the dataset for consistency. The datasets were then combined into a larger dataset containing all the variables.

Date	Bitcoin Price	Dollar Index	Inflation Rate	Interest Rate	Unemployment Rate
2014-07-01	603.0000	88.9483	0.01992	0.09	6.2
2014-08-01	596.8900	89.7677	0.01700	0.09	6.1
2014-09-01	498.9900	91.0844	0.01658	0.09	5.9
2014-10-01	374.5342	92.1952	0.01664	0.09	5.7
2014-11-01	330.3000	93.5410	0.01322	0.09	5.8
...	...	...	...	...	...
2022-03-01	44422.2000	111.2659	0.08542	0.20	3.6
2022-04-01	46264.0000	111.8324	0.08259	0.33	3.6
2022-05-01	38489.0000	114.6075	0.08582	0.77	3.6
2022-06-01	29816.6000	115.6957	0.09060	1.21	3.6
2022-07-01	19280.0000	118.2674	0.08525	1.68	3.5

97 rows × 5 columns

To perform exploratory data analysis, a first basic check was done on each variable by displaying their descriptive statistics, such as the mean, standard deviation, minimum, and maximum. This step ensured that the data did not contain outliers or strange deviations. The variables were visualized with line plots since they were time series. The last step was to check the correlation between variables with a heatmap. This showed that inflation rate and Bitcoin had a high correlation with each other.

Correlation Heatmap
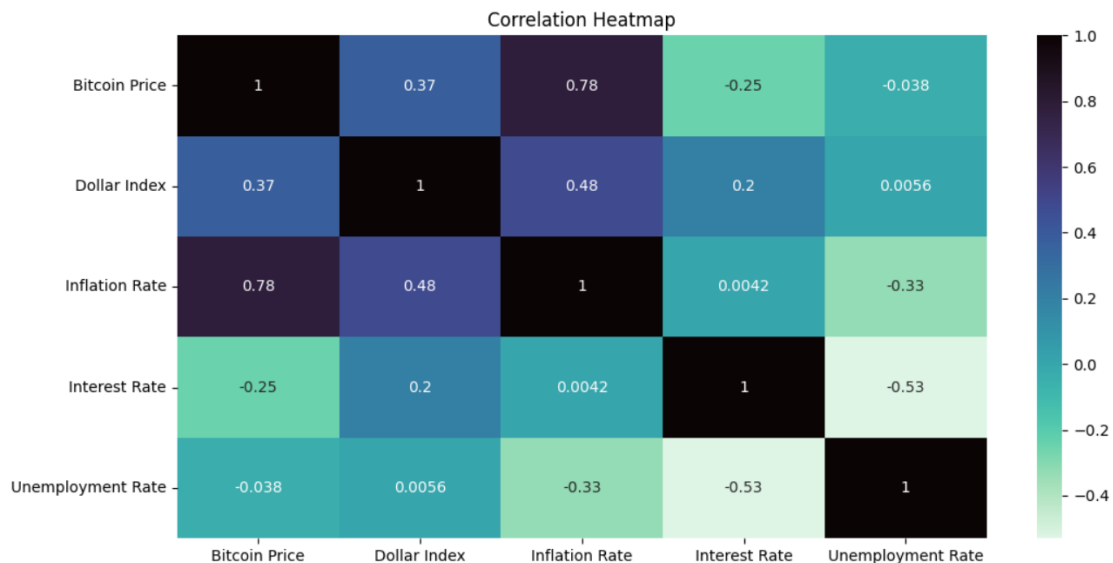
Before time series analysis was performed, the time series needed to be stationary. This meant the mean, variance, and covariance must be constant (Singh, 2020). Most statistical models required stationarity before fitting. The Augmented Dickey-Fuller Test

was performed it indicated that the variables were not stationary. To stabilize the variables, differencing was performed twice to remove trend and seasonality.

```python
# First differencing
diff_df = df.diff().dropna()

print('First Differencing\n')
stationary_test(diff_df)
```

First Differencing

Variable	P-Value	Stationary
Bitcoin Price	0.199	False
Dollar Index	0.002	True
Inflation Rate	0.216	False
Interest Rate	0	True
Unemployment Rate	0	True

```python
# Second differencing
diff_df = diff_df.diff().dropna()

print('Second Differencing\n')
stationary_test(diff_df)
```

Second Differencing

Variable	P-Value	Stationary
Bitcoin Price	0	True
Dollar Index	0	True
Inflation Rate	0.011	True
Interest Rate	0	True
Unemployment Rate	0	True

This analysis was designed to test whether multiple time series affected each other. To do that, a multivariate time series analysis technique was required. Vector Autoregression (VAR) fulfilled this criterion. It could model multiple time series and captured the relationships between them. Fitting the model resulted in a regression equation from the input variables.

```
  Summary of Regression Results
==================================
Model:                        VAR
Method:                       OLS
Date:            Mon, 12, Sep, 2022
Time:                    11:08:07
----------------------------------------------------------------
No. of Equations:      5.00000    BIC:                   3.16118
Nobs:                  94.0000    HQIC:                  2.67736
Log likelihood:       -747.327    FPE:                   10.4894
AIC:                   2.34949    Det(Omega_mle):        7.69818
----------------------------------------------------------------
Results for equation Bitcoin Price
================================================================================
                     coefficient      std. error        t-stat          prob
--------------------------------------------------------------------------------
const                -159.949679      522.300698        -0.306         0.759
L1.Bitcoin Price       -0.227687        0.102477        -2.222         0.026
L1.Dollar Index       627.309202      411.367310         1.525         0.127
L1.Inflation Rate  152505.523026   154616.582980         0.986         0.324
L1.Interest Rate     2829.615243     3955.898697         0.715         0.474
L1.Unemployment Rate  354.224917      349.821909         1.013         0.311
================================================================================
```

Findings

Based on the model, the regression equation was:

$$y = -159.95 + (627.31 \times \text{Dollar Index}) + (152{,}505.52 \times \text{Inflation Rate}) + (2{,}829.61 \times \text{Interest Rate}) + (354.22 \times \text{Unemployment Rate})$$

However, the variables were not statistically significant. This was indicated based on the variables' probabilities being less than the t-statistics. Another indicator that the equation was problematic was the coefficient of the inflation rate. The value of 152,505 was an extreme outlier. It meant any slight change to inflation would lead to a sharp increase or decrease of Bitcoin price. Therefore, the result of the analysis showed that macroeconomic factors did not affect Bitcoin.

Limitations

The first limitation in this model was the data themselves. Since Bitcoin had a short history, other variables were truncated to fit with Bitcoin. Having more long-term data would help the model to be more accurate. The second limitation was the VAR technique. While it could detect the relationship between the variables, the result was only an estimation. That meant if more details were needed, a different time series analysis technique would need to be used.

Proposal

Based on the analysis, the recommendation would be to perform additional analyses using different inputs. The result here showed that Bitcoin was not affected by these macroeconomic factors. But the same could not be said for other variables. As Bitcoin grows into a mature asset class, it could become less volatile and may even follow traditional market cycles. By running more experiments, Bitcoin's characteristics and its relationship to the economy could be uncovered.

Benefit

The primary benefit of this study was that it showed how Bitcoin was not following the traditional economic cycles. This could be an important point to consider in future analysis. Even if the variables were not statistically significant, their positive coefficients indicated that Bitcoin could be used as a hedge in economic downturns. When inflation, interest, and unemployment rise, the economy tend to be in a negative territory. If Bitcoin values rises at the same time, it can offset potential losses in other markets.