AALBORG UNIVERSITY BUSINESS SCHOOL

MACRO-ECONOMIC DETERMINANTS OF BITCOIN RETURNS: EVIDENCE FROM OLS, VAR, AND ARDL MODEL

Written by:

Prajwal Bhattarai

20231170

A dissertation submitted for the master's degree in:

Master of Science in Finance

Supervised by:

Douglas Eduardo Turatti.

Date of Submission:

2026/01/04

Abstract:

This research paper analyses the relationship between macro factors and bitcoin returns. From 2015 to 2025, we have used weekly time-series data to examine how interest rate, inflation, money supply, economic policy uncertainty index, and dollar index influence bitcoin returns in the short-term and long-term. This study consists of multi-model empirical methods such as OLS, ARDL, and the VAR model.

The results show that, especially the monetary factors such as interest rate and inflation has higher impact on bitcoin's return among all the variables. A strong negative relationship between dollar value and bitcoin returns is generated from OLS and ARDL model indicating that, rise in dollar value declines the bitcoin's return. The result further shows that, bitcoin can work as a hedge asset in short-run when inflation is expected to rise since inflation and bitcoin has positive relationship. With a delayed response to economic uncertainty shocks, EPU affects Bitcoin's return with a lag. However, the money supply shows weaker direct effects.

From the VAR and ARDL-ECM results, it was found that, adjusting rapidly towards long-term equilibrium, Bitcoin responds dynamically to macroeconomic shocks. Overall, bitcoin is a macro-sensitive asset, rather than a fully independent alternative to traditional assets.

Acknowledgement:

I would like to thank my supervisor for the support, guidance, and continuous support throughout the development of this research paper. His guidelines, and support were instrumental in shaping the direction and improving the quality of this work.

I would also like to thank Aalborg University and my professors of Finance department for providing the resources and a better environment that helped during my study period and completion of my master's degree.

Table of Contents:

Abstract……………………………………………………………………………………..2

Acknowledgement…………………………………………………………………………..3

1. Introduction:……………………………………………………………………………6

1.1 Background of the Study……………………………………………………...6

1.2 Importance of Macro Factors ……………………………………………………...7

1.3 Motivation of the Study……………………………………………………………….9

1.4 Research Purpose and Questions…………………………………………………10

2. Literature Review:……………………………………………………………………10

2.1 Interest Rate and Bitcoin………………………………………………. …..10

2.2 Money Supply and Bitcoin…………………………………………………………11

2.3 Inflation and Bitcoin………………………………………………………...13

2.4 Dollar and Bitcoin……………………………………………………………..14

2.5 Economic Policy Uncertainty Index and Bitcoin ………………………………. 16

3. Data and Methodology ………………………………………………………………17

3.1 Overview………………………………………………………………………...17

3.1.1 Bitcoin Returns…………………………………………………………………17

3.1.2 Interest Rate………………………………………………………………………17

3.1.3 Inflation Rate……………………………………………………………………...18

3.1.4 Dollar Index………………………………………………………………………18

3.1.5 Economic Policy Uncertainty Index……………………………………………18

3.1.6 Money Supply ……………………………………………………………………18

3.2 Methodology……………………………………………………………………..19

3.2.1 Augmented Dickey-Fuller Test…………………………………………………20

3.2.2 Correlation Matrix………………………………………………………………20

3.2.3 Multicollinearity Test…………………………………………. …………….21

3.2.4 Heteroskedasticity Test…………………………………………………………21

3.2.5 Ordinary Least Squares…………………………………………………………22

3.2.6 Vector Auto-Regressive ………………………………………………………..23

3.2.7 Auto-Regressive Distributed Lag………………………………………………..25

4. Empirical Research:……………………………………………………………………….26
4.1 Descriptive Statistics……………………………………………………………….26
4.2 Correlation Matrix…………………………………………………………………….27
4.3 Augmented Dickey-Fuller Test……………………………………………………….27
4.4 Multi-collinearity Test……………………………………………………………...28
4.5 Heteroskedasticity Test…………………………………………………………….28
4.6 Ordinary Least Square……………………………………………………………...29
4.7 Auto-Regressive Distributed Lag …………………………………………………….32
4.7.1 Error Correction Model: Short Run Dynamic………………………………….35
4.7.2 ECM Derived from ARDL ……………………………………………………..35
4.7.3 Diagnostic Test…………………………………………………………………….38
4.8 Vector Auto-Regressive ……………………………………………………………...41
4.8.1 VAR Estimation……………………………………………………………….42
4.8.2 Granger Causality Test……………………………………………………………47
4.8.3 Impulse Response Function ……………………………………………………...48
4.8.4 Forecast Error Variance Decomposition ………………………………………49
4.8.5 Diagnostic Test…………………………………………………………………….50
5. Conclusion………………………………………………………………………………51
6. Relevant to Past Studies………………………………………………………………...53
7. Importance of This Research……………………………………………………………54
8. Limitation of the Study…………………………………………………………………55
Appendix………………………………………………………………………………….56
References…………………………………………………………………………………66

1. Introduction:

1.1 Background:

The digital gold, Bitcoin (BTC) has gained massive popularity in a financial market over a decade. Based on an idea of free-market ideology, bitcoin, the digital gold was invented in 2008, when a non-disclosure organization released a white paper under the fictious name Satoshi Nakamoto. After the publication of its open-source implementation, bitcoin was started to use as currency in 2009. Since, the early phase of bitcoin was tiny, the early adopters of BTC, Satoshi and other small peers tested with small transactions, mining and client software's. The initial phase included small value payments and the test of technical concepts for developmental and experimental purposes.

As of January 2025, the total cryptocurrency industry has a market cap of 3.46 trillion dollar. The industry has been growing rapidly due to the increment in adaptation of blockchain technology and rise in demand for decentralized finance(defi), institutional investments and regulatory advancement. With the success of Bitcoin, many alternative coins (altcoins) have been introduced in the cryptocurrency industries such as, Ethereum, Litecoin, Solana Ripple etc. with each coins having their own functionality, purpose and use case.

As bitcoin is often regarded as digital gold, as it has been able to preserve an investor's purchasing power against inflation. Over the last 13 years, bitcoin has an annual compound growth rate of 102.41% with a standard deviation of 150.5% and a Sharpe ratio of 0.83. Over the last ten years Bitcoin had a total return of 38906.1%. on the flip side, over the same period, S&P500 has an compound annual growth rate of 14.71% with standard deviation of 14.42% and a Sharpe ratio of 0.96. Similarly, over the last 10 years, S&P500 has a total return of 259.9%. This clearly shows, Bitcoin gives more return compared to S&P500. (Curvo.eu)

Although, Bitcoin has provided investors with highest returns, it is more volatile compared to S&P500. For Bitcoin, the largest drawdown period lasted for 3 years and a month between November 2013 and December2016. Throughout this period, Bitcoin fall by -76.7% respectively. S&P500 on the other had given an average return annually throughout Bitcoin drawdown period from 2013 to 2016. (Curvo.eu)

Figure 1: Bitcoin price history
Source: (Curvo.eu)

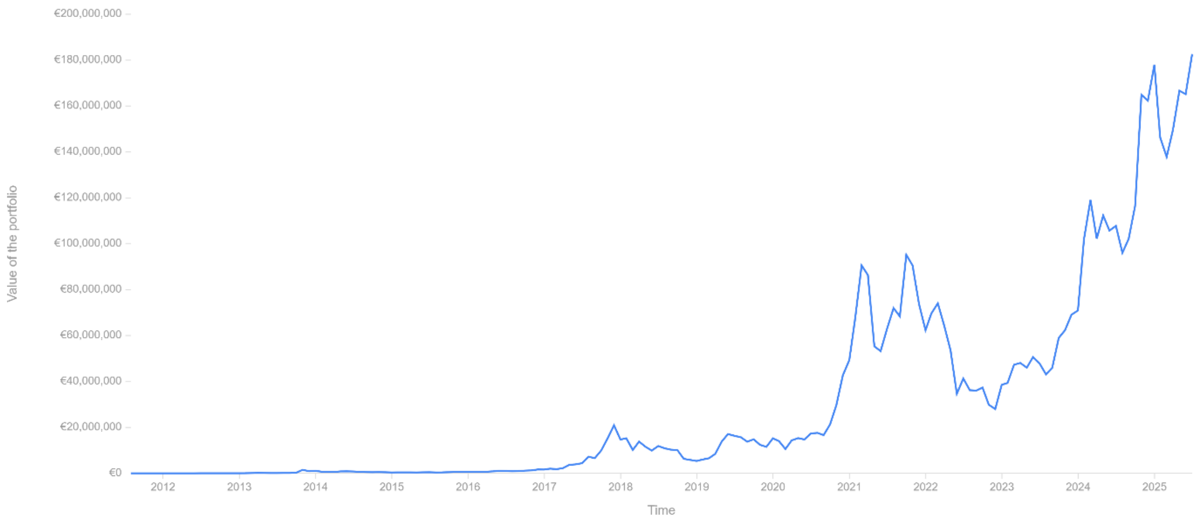
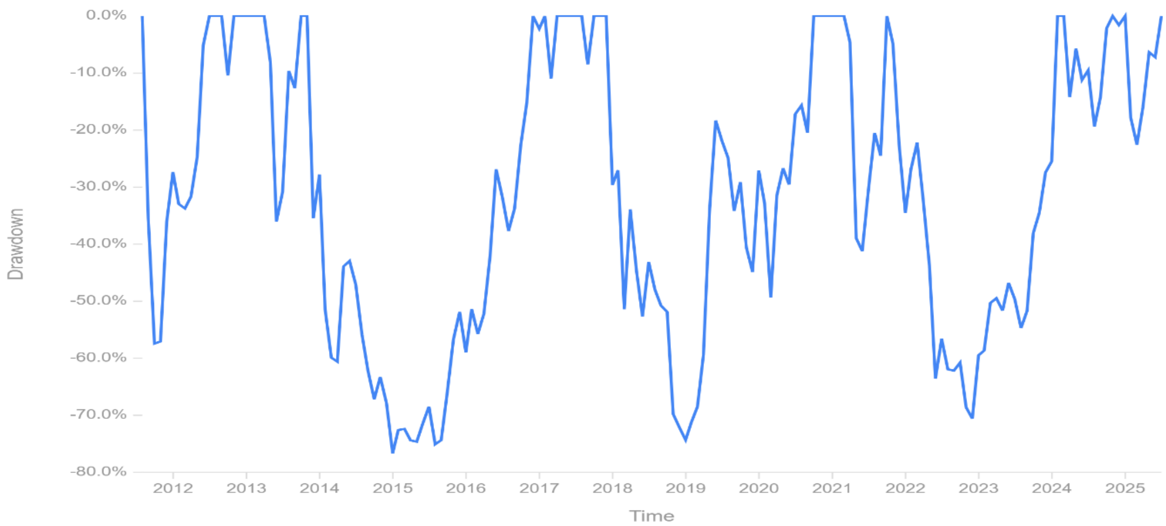


Figure 2: Bitcoin drawdown
Source: (Curvo.eu)



1.2. Importance of Macro Factors:

Money Supply:

Money supply has a critical effect on the financial and capital market development and stability. It is empirically verified that traditional assets have a positive relationship with money supply and monetary policy (Conover et al., 1999; Sousa, 2010; Harjoto et al., 2021). Although this study has been done on stock market, several studies has also been done to test its impact on alternative assets. For instance, Miao (2016), came up with a conclusion that money supply had a significant effect on the interaction between alternative assets like, bond, real estate.

Although, monetary policy and money supply had no prior effect on Bitcoin has been concluded by several researchers, it is found out that Bitcoin started reacting on money supply and monetary policy after late 2020 (Karau's. 2023). In addition to that, especially in the emerging markets, positive central bank policy has affected Bitcoin trading volume (Marmora, 2022).

Interest Rate:

As interest rate provides opportunity cost for the investors, higher interest rate increases the discount rate which decreases the present value of assets (Bernanke, B. S., & Blinder, A. S.1992). To make a better financial decision, it is important to understand the role of interest rate and its impact on any financial assets. The price of any financial assets such as stocks and bonds is strictly sensitive to the change and decision of interest rate. Furthermore, investor behaviour is also impacted by interest rate, which means, when interest rate decreases investors try to gain higher returns investing in riskier assets and when the interest rate increases, investors try to shift towards safe assets (C Lian, 2019).

Economic Policy Uncertainty Index:

Economic policy uncertainty index is another important macro factors that shows the uncertainty linked with government policy, taxation, regulation and geopolitical decisions. When uncertainty rises it shows it typically shows political instability, economic stress, changes in policy or global shocks that influence investors expectations.

Linking up economic policy uncertainty and traditional assets, many researchers have found and stated that there exists a negative relationship between them. Corporates tend to postpone investment and hiring decisions, household starts to save money rather than spending on consumption, economy tends to have lower growth is associated with rise in uncertainty. Empirical research has shown that when economic uncertainty rises, stock market generally falls. (Baker et al 2016)

Dollar Index:

Another factor that impacts financial assets is USD. Dollar has a strong relationship with financial assets such as stocks, bonds. Derivatives and others. (Emerald/ Finance and Markets, 2022) found that, US stock market returns falls when the dollar tend to increase its value since increasing the dollar price decreases the profitability of multinational companies when foreign revenues are converted to USD.

Inflation:

Lastly, inflation is another crucial factor that affects assets price in our report. (Cieslak & Pflueger, 2023) Good inflation which comes from increase in demand boosts assets price because in such condition companies sells more products and their revenue and profit increases. Bad inflation which comes from increase in oil price or shortage of oil, decreases the assets price because of higher manufacturing cost and uncertainty which lowers firms' revenue.

1.3 Motivation of the Study:

Since the end of global pandemic COVID-19, huge number of cryptocurrencies have emerged in the crypto markets attracting many investors. Although, there are thousands of cryptocurrencies listed in different exchanges, Bitcoin remains the most traded, expensive and is seen as leader crypto in the market.

The global financial market has been severely impacted since the rapid of blockchain industry. During the initial phase of Bitcoin, it was used as peer-peer payment system. However, it has been able to attract many institutions, investors, retailer and even government as well.

Compared to traditional assets such as bonds, equities and commodities, Bitcoin is freely operated with no restrictions by central bank or is not directly tied to any economy. The out-of-control nature of Bitcoin has sparked a debate in financial market regarding its economic role, especially whether Bitcoin can save investors capital or money during rising inflation or is it a store of value or is Bitcoin an alternative asset or not. Regardless of this financial claim the empirical evidence for Bitcoin remains conflicting, especially analysing which factors influence its return the most.

Financial markets often take time to adjust or react to the macro factors shock and assets normally reacts differently depending upon time consideration. For instance, Bitcoin may fluctuate in the short term due to liquidity, market sentiment and huge speculation driven trading activity. However, in the long run Bitcoin may generate higher return, may show resistant relation with macro factors and balanced relationship. Therefore, this is also the another motivation of our study to analyse the short run and long run dynamics between bitcoin and macro factors.

In addition to that, another motivation of this study is to analyse the return dynamics between bitcoin and macro factors. Furthermore, the research is motivated by the practical usefulness for the investors, academic students, policy makers and institutions. This research may help for better portfolio allocation to maximize return and reduce the risk.

1.4 Research Purpose and Question:

The main objective of this report is to examine how interest rates, money supply (M2), Economic Policy Uncertainty Index, dollar index, and inflation impact Bitcoin returns. While traditional financial assets have been widely studied in relation to these macroeconomic factors, cryptocurrencies such as Bitcoin remain new and potentially behave differently due to their unique features and usage. This report focuses on:

1. How do macro factors affect bitcoin return?
2. Examine the dynamic relationship between Bitcoin and macro factors.
3. Study the short-term and long-term relationship.
4. Identify causal direction between Bitcoin and macro factors.

2. Literature Review

Analysing the existing research based on the relation between macro variables and bitcoin in terms of return is the main motive of this section. We study the academic literatures that are related to this thesis under this section. Since we have already discussed the impact of macro-economic variables on traditional assets, we examine the impact of same macro-factors in relation to Bitcoin's return. Like traditional assets, it is equally important to analyse how these macro-economic variables affect Bitcoin's return since Bitcoin has been transformed from speculative assets to a globally traded and owned digital assets sensitive to macro instruments.

Firstly, we examine the literatures that discuss how Bitcoin reacts to our macro-economic factors in terms of assets pricing theory and behavioural finance. Secondly, we investigate empirical studies that shows how Bitcoin reacts to change in interest rate, inflation, money supply, consumer sentiments and dollar index. Lastly, we focus on finding out the literature gaps on addressing return of bitcoin. These gaps will assist to develop conceptual framework and develop hypothesis in upcoming sections.

2.1 Interest Rate and Bitcoin:

To determine the value of financial assets, interest rate plays an important role, and its impact can be seen in cryptocurrencies especially Bitcoin as well. As the classical assets pricing theory suggest that the opportunity cost of holding non-yielding assets like Bitcoin increases when interest rates spike, as investor try to maximize their returns by investing in safer and interest generating assets such as bonds or saving accounts. This clearly proves that there exists a negative relationship between Bitcoin and interest rate. In addition to that, when interest rate rises, the discount rate used to forecast the future cash flow increases which results in lower present value of risky and speculative assets resulting in decreasing demand of the assets. On the contrary, when interest rate decreases, investor try to maximize return by investing in risky assets like Bitcoin.

Although the degree of strength and direction of relationship between interest rate and Bitcoin may vary across different studies and periods of time, this theoretical link has been empirically supported. According to Smales (2019), Bitcoin tends to perform weakly and gives lower returns when interest rate rises, indicating that when interest rate rises, the economy faces monetary tightening which reduces speculative investment. Likewise, fluctuation in the U.S term structure of interest rate has a direct impact on Bitcoin's return and volatility, indicating that Bitcoin has been connected to global macro-financial dynamics. (Ahron, Umar and Vo. 2021).

Since bitcoin experienced a bull market from first quarter of 2023, many institutional investors began to invest heavily on cryptocurrencies. Since then, Bitcoin has become more sensitive toward any monetary policy changes, behaving like a traditional financial asset (Baur et. Al. 2021). However, some literatures and researchers have come with different conclusion as well. For example, Kristoufek (2020) and Corbet et al. (2020), stated that, there are some time periods when Bitcoin has negatively reacted to rise in interest rate although this period did not last longer.

Bitcoin gained from abundant speculative capital and easy monetary policy, during 2016 to 2020 when interest rates were low and high liquidity. Although, due to aggressive rate hikes recorded post 2021 monetary tightening period, Bitcoin failed to give positive returns supporting the traditional assets pricing forecast. Bitcoin valuation has been affected by judgement-based monetary policy as it altered liquidity and investor risk bearing capacity (Karau 2023). Furthermore, behavioural finance also supports the idea that, when interest rates are low, investors try to invest more as their risk-taking capacity increases whereas, rising interest rates diverts investors toward yield generating assets such as bonds and saving accounts which often increases volatility.

2.2 Money supply and Bitcoin:

In macro-economic and monetary policy, money supply is one of the most important fundamental variables. Money supply shows change in spending, economic slowdowns and growth within the economy. The total amount of currency and liquid assets that are being circulated within an economy is shown by the money supply. When money supply changes, it impacts the liquidity, expected inflation, price of financial instruments and investors risk taking capacity. Economist, Friedman 1956, in his book Quantity Theory of Money explains that, when money supply increases rapidly, it increases the price of goods in economy and reduces the purchasing power of fiat money. On the other hand, during the period of monetary contraction, liquidity falls, and economic activity slows down.

Since, Bitcoin has a fixed supply of 21 million coins. In contrast, fiat currency can be printed whenever needed by the central banks. Therefore, fiat money can lose its value causing inflation in the economy while Bitcoin's fixed supply makes its rarer and works as an instrument to beat inflation.

Through the two main channels, liquidity and inflation, money supply and Bitcoin relationship can be examined from a theoretical point of view. When the economy enters the phase of Quantitative Easing, central bank prints more money and injects liquidity in the economy with lower interest rates. Since the interest rate is lowered, investor try to maximize their return by injecting their capital into speculative and risky assets, which causes price to move upward. On the flip side, when economy enters quantitative tightening, interest rate rises and liquidity decreases, this creates fear in investor, and they shift their investment towards safe and yield-bearing assets. With the liquidity channel observed in broader economic perspective, this phenomenon is consistent (Brunnermeier & Pedersen 2009).

Though the relationship between Bitcoin and Money supply is not always stable, empirical evidence has supported the idea that, change in money supply affects Bitcoin price. Especially during the early stage of pandemic, when money supply increased during that period, Bitcoin generated higher returns showing that liquidity driven speculation played a major role in Bitcoin rally (Goodell and Goutte 2020). Furthermore, money supply expansion has a positive relationship with cryptocurrency market, particularly during the period when economy is slowing down (Arahon and Qadan, 2022). In contrast, Bitcoin price and market capitalization fell sharply during the period of Federal Reserve Monetary tightening period between 2022-2023, because of liquidity tightening. This resulted in slowing down the demand of risky and speculative assets (Baur & Dimpfl, 2023).

From the behavioural point of view, the impact of money supply on Bitcoin is derived by investors sentiment and perception. The period of monetary easing leads retail and institutional investors towards Bitcoin. Concern about currency stability and increasing inflation expectation drives investor to invest capital into Bitcoin, suggesting that monetary expansion via liquidity not only impacts cryptocurrency price but also through psychological channel (Cong, Ghosh & Li, 2024).

Having said that, not all literatures agree on the same strength and performance of relationship between money supply and Bitcoin. Kristoufek (2020) came up with a conclusion that, impact of monetary variables on Bitcoin heavily depended upon market maturity and composition of investors. Bitcoin price in its early phase was driven by internal factors such as news, change, technology, but since the institutional investor has begun investing in Bitcoin macro-factor linkage and money supply effect became even more stronger. Furthermore, Ahron, Umar and Vo. 2023 and Leu et. Al 2023 found that Bitcoin volatility increases during the time of monetary contraction and returns tends to be negative when investor has negative sentiments.

2.3 Inflation and Bitcoin:

In general term, inflation refers to the increase of price of goods and services due to the decline in purchasing power of money. In finance, inflation can be seen as major macro variables that impacts assets price, return and volatility. The economic theory suggests that the purchasing power or fiat currency declines over time due to inflation, which makes investor to shift their investment towards safe assets that can preserve their capital. Since bitcoin is a decentralized assets having fixed supply of 21 million coins, it has been seen as digital gold to hedge against inflation. However, many literatures found that its effect on return and volatility is not the same always, which means the relation is mixed and is depended on expected inflation, time-period and monetary policy change.

If we look at inflation through theory of asset-pricing, inflation affects the real return and the discount rates. Following the fisher effects, when inflation rises in the economy, nominal interest rate also rise which increases the discount rates making risky and speculative assets less attractive. However, for bitcoin this theoretical linkage depends upon two perspectives: firstly, whether investor view Bitcoin as a speculative asset which is impacted by change in interest rate, secondly, does investor look Bitcoin as store of value against rising inflation. From the behavioural approach, investor risk taking capacity or sentiment is affected by inflation as well. When investor fear that their money is losing its purchasing power, they may inject their capital to Bitcoin for hedging against inflation which results in increasing volatility of Bitcoin price because of herd behaviour (Baur et. Al 2021).

From the empirical point of view, several researchers have examined the relationship between inflation and bitcoin returns. Through time-series analysis and Granger Causality test, (Blau, Griffith and Whitby 2021), found that it is bitcoin returns that changes expected inflation rather than inflation changing Bitcoin returns. Furthermore, using survey-based inflation expectation from the developing economy, it was observed that when inflation is expected to rise rapidly, number of cryptocurrency holders also rises simultaneously, especially bitcoin perceiving it as inflation hedge assets.

However, there are some researchers that came with contradictory conclusion as well. It was found out that Bitcoin working as a hedge assets against inflation was not always true, rather, it was limited and inconsistent. Especially during the Covid-19 crisis, bitcoin and inflation relation was stronger whereas, when economy was stable and during the period of low inflation the relation was weaker was found using Wavelet coherence analysis (Bouri et. Al 2021). Rather than the fundamental inflation, it was found that bitcoin behave more like speculative assets influenced by liquidity and sentiment over a long-term period. In addition, using VAR model, it was found that, impact of inflation on Bitcoin returns only lasted for short period of time (Conlon, Corbet, and Mc Gee 2022).

On the other hand, it is also equally important to look at the impact on bitcoin's volatility in relation to inflation. Deploying GARCH and EGARCH model, Dyhrberg (2016), found that Bitcoin behaviour was like Gold and US Dollar, it responded asymmetrically to negative and positive inflation shocks showing huge spike in volatility especially when inflation was seen increased unexpectedly. Furthermore, Conlon and McGhee 2020, found that, rather than stable behaviour, Bitcoin behaves like a speculative nature when volatility increased due to rise in inflation.

Further literatures suggest that Bitcoin is a high beta and liquidity sensitive assets rather than hedge, since it was found that, compared to traditional assets, bitcoin realized volatility rose disproportionately with increase in one standard deviation in expected inflation, using time varying parameter VAR. (Umar, Arhon and vo 2023).

2.4 Dollar and Bitcoin:

Since US is the world's largest economy, US Dollar is the most traded currency in the world. The US Dollar Index (DXY) measures the value of US Dollar against other major currencies such as Euro, Yen, Swiss Franc etc. It helps for maintaining the standard for USD Strength against other major currencies and depicts the degree of demand for US assets in the international market. In relation to bitcoin and dollar, fluctuations in dollar have significant impact in Bitcoin's return and volatility. Strong rise in dollar indicates difficult economic situation or tighter US monetary conditions which indicates shrinking global liquidity and shows investors are not interested towards risky and speculative assets. On the other hand, when dollar lose its value, it shows monetary easing and rising demand for speculative assets which drives Bitcoin price higher.

The inverse relationship between bitcoin sensitivity to global risk sentiment and liquidity can be seen through assets pricing theory since, global liquidity condition and investors demand for holding dollar-dominated assets are captured by dollar. To explain it further, when the value of dollar is increasing, it indicates the flow of capital in US-market and global financial market getting worsen. This increases the cost of holding risky assets like Bitcoin to the investors. (Shahzad et al., 2022)

Also, the relationship between bitcoin and dollar can also be seen through behavioural finance perspective. To begin with, weakening dollar creates a fear on inflation and concerns about dollar losing its intrinsic value. This increases demand for Bitcoin since investors hedge Bitcoin against inflation and against reducing purchasing power (Baur and Dimpfl, 2023)

There has been much research conducted on verifying the relationship between dollar and Bitcoin. Most of the research has shown the inverse relationship between these two variables. One research shows that; there has been a long-term inverse relationship between Dollar Index (DXY) and Bitcoin. Rising value dollar has resulted in lowering the Bitcoin's return, saying that, when dollar increases demand for speculative assets decreases (Ahmadova, Guliyev, and Aliyev 2023). This evidence has been supported by another literature, concluding that, DXY shocks results in negative Bitcoin's return particularly under economic stress.

On the other side, some researchers have claimed that the relationship between these two depends on global monetary regime. When applying the data between 2015 to 2024, (Journal of risk and Financial Management 2025), concluded that relationship between bitcoin and DXY fluctuated on time and frequency domains. These two variables have strong negative correlation during the period of monetary expansion, and the correlation disappears during stable economic period. This finding concludes that bitcoin behaves more like a liquidity sensitive asset rather than consistent hedge against dollar value.

Similarly, researchers have analysed the volatility impact on bitcoin due to change in dollar index and value as well. Research has shown that especially during loose monetary policy when dollar tends to depreciate its value rapidly, bitcoin volatility is expected to rise since investor starts to increase investments on speculative assets. When DXY increases it leads to decrease in bitcoin volatility Aliu et al. (2023).
Likewise, this perception was supported by 2025 Journal of Risk and Financial Management Study, who found that the relationship between bitcoin volatility and DXY is nonlinear and asymmetric. During the period when dollar lose its value bitcoin seems to be more volatile compared to period when DXY strengthens. This asymmetric relation shows speculative overreaction to perceived fiat currency debasement, a pattern reflecting to behavioural finance theories of risk seeking during expansionary monetary periods.

2.5 Economic Policy Uncertainty Index and Bitcoin:

Economic uncertainty refers to the period when future of is not certain or unsure. It includes expected or projected growth, inflation, interest rate, policies and global events. In other terms, it refers to the period when economic events are unpredictable and a period when it is difficult to make any informed decisions. Economic uncertainty index has been thoroughly visualized and analysed by the investors these days. Since, period during uncertainty increases risk premia and supress investment inflows which results in increasing volatility for traditional assets. However, this relationship has been analysed by number of researchers to examine whether the same relationship holds between cryptocurrencies and economic uncertainty.

Large number of researchers has found that, when economic uncertainty rises, it leads to increase in volatility and depress Bitcoin's return. However, this phenomenon is regime dependent. In addition to this, several other research found that, when there is shock in uncertainty, Bitcoin has given negative abnormal return in short term. For instance, (Smales 2021) and (Corbet et. Al 2020) found out that, investors reduce their investment in speculative assets when uncertainty rises. Furthermore, during such situation, investors generally expect lower Bitcoin returns for short term. Also, when uncertainty rises, demand for speculative digital assets decreases while capital transforms from speculative assets to safe assets such as Gold, cash and Tresuries.

On the other hand, volatility has more robust relationship. Using several GARCH models, researchers found that, uncertainty has positive relationship with Bitcoin's conditional volatility. For example, (Bouri et al 2023) found that, there was an immediate spike in Bitcoin's volatility when uncertainty experienced shocks and that shock in uncertainty explained a long run realized volatility of Bitcoin. This phenomenon was seen mostly when there was fear in investor of intensify trading activity, leverage dynamics especially during crisis period like Covid-19.

3. Data and Methodology:

3.1 Overview:

The main objective of this thesis is to find out the relationship between macro factors and Bitcoin. In addition, here, we analyse how money supply, interest rate, inflation, economic uncertainty and dollar impacts bitcoin return. The dataset consists of weekly observations from January 2015 to the end of April 2025 with altogether 539 observations. All the data set are obtained from FRED official website https://fred.stlouisfed.org/. The data set consist of altogether six variables out of which Bitcoin is regarded as dependent variable and other macro factors: money supply, interest rate, dollar, inflation and economic uncertainty are independent variables.

3.1.1 Bitcoin Returns:

Bitcoin is our dependent variable in our research. Here, Bitcoin represents the difference in weekly closing price. In other words, Bitcoin represents the absolute weekly change in price measured in USD. Although log returns or percentage change are widely used in financial data studies, we have used the first differenced of raw data in our study.

Bitcoin raw data was highly non-stationary, because the price level was increased exponentially over the time, with large bubbles of bull and bear period. Applying the first difference of raw data has resulted in stationary of the time series.

Finally, the first differenced of raw price reduces the chance of autocorrelation and heteroskedasticity all of which would create problem in statistical reliability of our research.

3.1.2 Interest Rate:

For the interest rate we have used Federal Reserve Effective Rate and similar to bitcoin, we have used first differenced of raw interest rate. For the interest rate we have used weekly data which was available in FRED official website.

The other reason to difference the raw was that, financial assets are affected more immediately to change in monetary policy rather than static interest rate levels.

The first difference of raw data captures these adjustments directly. In our data set, positive difference indicates increase in interest rate and negative difference indicates rate cuts.

3.1.3 Inflation:

Here, in our study, instead of using consumer price index or realized inflation, we have used expected inflation for next five years. The expected inflation shows what consumer, institutions and government authority expects the level of inflation in next five years.

Since inflation data almost remains stable for long period of time with few changes during monetary policy announcement, the raw data of inflation becomes non-stationary. Therefore, the raw data of expected inflation is also first differenced in our study.

In the upcoming section of this report, expected inflation has been explained as inflation.

3.1.4 Dollar Index (DXY):

The DXY measures the power of dollar in comparison to other foreign currencies. In our report, instead of using raw data of DXY we have first differenced the raw data. This was demanded by the statistical requirement for making the data stationary as raw data was non-stationary.

3.1.5 Economic Policy Uncertainty:

Economic policy uncertainty is another widely used factor used for analysing decisions related to policy, geopolitics tensions, and macroeconomic stability. Economic policy uncertainty index is formulated studying the times of newspaper articles published related to policy uncertainty showing the media's focus on economic ambiguity.

In this report, instead of using raw data of EPU, we have first differenced the raw data. This was done in order to make the data stationary.

3.1.6 Money Supply:

Money supply represents the broad liquidity conditions in the country that includes cash, deposits and liquid savings. Money supply is first differenced in our report to make it stationary.

Data	Symbol

Bitcoin	BTC
Interest Rate	INT
Inflation	INF
Economic policy uncertainty Index	EPU
Money supply	M2
Dollar Index	DXY

3.2 Methodology:

Here, in our report, we are using multi-model econometric strategy to analyse how macro factors fluctuations impacts Bitcoins return and volatility in a weekly time. Since, Bitcoin reacts quickly and macro-economic shocks operate through multiple ways, a single methodological approach cannot study the complexity of these interactions and relationship. Therefore, we are using following approaches in our study:

1. **Augmented Dickey-Fuller Test:** examine the stationary of our time series data.
2. **Correlation Matrix:** examine the correlation between all variables.
3. **Multicollinearity Test:** examine whether independent variables are highly correlated to each other or not.
4. **Heteroskedasticity Test:** examine whether the residuals of error terms have constant variance over time or not.
5. **Ordinary Least Square:** estimate relationship between Bitcoin and macro factors.
6. **Vector Autoregression (VAR):** capturing dynamic relationships among all the factors.
7. **Auto Regressive Distributed Lag (ARDL):** examine short run and long run relationship between all the factors.

This multi-approach study insures to study return dynamic between Bitcoin and macro factors. Before any empirical analysis we have used first differenced data in our study for all the variables including dependent and independent variables since they were non-stationary in raw form. Differencing helps in making the data stationary and removes long-term trends and allows the empirical model to analyse and study the short run trends.

The Ordinary Least Square is the first model that we deploy in our empirical analysis since it gives foundation for the relationship between bitcoin and other macro factors. It calculates the coefficient which can be very helpful in for deploying model advance empirical models.

In order to calculate the dynamic relationship, we are using VAR as other empirical model. It calculates lagged relationship. Since VAR analyse all variables as endogenous and also allows for rich feedback and mechanism, we have decided to utilise VAR model in this study.

Finally, ARDL model is used to study the short run dynamics explaining how one variable behave after change in other variables.

<u>3.2.1 Augmented Dickey-Fuller Test:</u>

Since we are using OLS, ARDL and VAR model in our report, we need stationary data for every models. Before estimating any models, we need to test the stationary of our data set. Therefore, we have used ADF test for the stationary check of our data set. Although our raw data were not stationary and would have violated the assumptions for every model we have first differenced the raw data in order to make it stationary.

The general expression for stationary can be expressed as:

$$\boldsymbol{\Delta Z_t = \alpha + \beta t + \gamma Z_{t-1} + \sum_{k=1}^{i} \delta i \, \Delta Z_{t-i} + \epsilon_t}$$

Where,

Z_t represents the variable under consideration

Δ represents the differenced data

T is the time period

K represents lag difference term

ϵ_t represents error term that is white noise.

Hypothesis:

$H_0 : \gamma=0$

$H_1 : \gamma<0$

The H_0 estimates that the time series has unit root and is not stationary, while H_1 indicates time series has no unit root and is stationary.

<u>3.2.2 Correlation matrix:</u>

before estimating any models it is very essential to anlayse the correlation between bitcoin and other macro factors. Since correlation between any variables should not be very high otherwise it would violate the assumptions of models we have used correlation matrix to analyse the correlation between all the variables.

The correlation between the variable lies within the range between +1 and -1, where +1 indicating strong positive relation and -1 indicating strong negative relation. High correlation between any variable may create a problem of multi collinearity.

3.2.3 Multicollinearity Test:

In order to make the model stable and reliable it is equally important to conduct a multicollinearity test. Multicollinearity occurs when two or more variable are highly correlated to each other and when this occurs our model would be invalid. Therefore, we have conducted Variance Inflation Factor to test the multicollinearity test.

The VIF for each explanatory variable can be expressed as:

$VIF_i = 1/(1-R^2_i)$

Where,

R^2 represents the coefficient of determination obtained regressing i-th explanatory variable.

Hypothesis:

H_0= independent variables has no multicollinearity issue

H_1= independent variables have multicollinearity issue.

3.2.4 Heteroskedasticity Test:

The other essential assumptions to be valid is heteroskedasticity test in our model. It refers to the situation where the error terms or residuals are not constant over time. In the empirical process, if the error term has no constant variance across time it leads to inefficient parameters and biased error terms which shows that our empirical model has unreliable statistical results.

Therefore, we have used Breusch-Pagan Test to examine whether the error terms has constant variance over time or not. The null hypothesis of Breusch-Pagan Test assumes constant variance across time of error terms and alternative hypothesis assumes the presence of heteroskedasticity.

The model specification for Breusch-Pagan Test is:

$\epsilon^2_t = \alpha_0 + \alpha_1 INT_t + \alpha_2 INF_t + \alpha_3 DXY_t + \alpha_4 EPU_t + \alpha_5 M2_t + \alpha_6 y_t + \mu_t.$

where,

ϵ^2_t represents squared residuals from estimated baseline regression

α_0 represents coefficient or intercept

y_t represents output which caputure the impact on variance of error term

μ_t represents the disturbance term.

Hypothesis:

H_0= error term has constant variance

H_1= error terms have heteroskedastic

3.2.5 Ordinary Least Square (OLS):

Ordinary Least Square is the first model that we are using in our analysis of general relationship between Bitcoin and macro factors. OLS is the first and major model in our analysis because it shows general relationship between the variables and estimates the linear relationship between dependent and independent variables. Since Bitcoins price may fluctuate in response to shock in macro factors or independent variables, the OLS model shows the direct measurement of immediate effect on Bitcoin due to shock in macro factors.

The general idea of using OLS method is that, since Bitcoin is volatile and fast-moving assets, it often reacts quickly to the macro factors. Choice of weekly timeframe data gives insightful information of short-term trends and relationship to change in interest rate, inflation, money supply, economic policy uncertainty and dollar index. Since our report has first differenced data, OLS captures how Bitcoin changes to change in macro factors. For our analysis and research objectives, OLS suits the best since it captures same week response of dependent variable to independent variables.

The dependent variable in our analysis is weekly closing price of Bitcoin which is transformed in first differencing (ΔBTC). This model captures the absolute change in Weekly closing price of Bitcoin in USD instead of percentage.

The OLS method studies the effect of five key independent variables, change in interest rate (ΔIR), change in expected inflation (ΔEI), change in Dollar index (ΔDXY), change in Money supply (ΔM2) and finally change in economic policy uncertainty (ΔEPU).

The OLS equation for our analysis is:

$$\Delta BTC = \alpha + \beta_1 \Delta INT + \beta_2 \Delta INF + \beta_3 \Delta DXY + \beta_4 \Delta M2 + \beta_5 \Delta EPU + \epsilon_t$$

Where,

α= intercept term

$\beta_{1.2.3..4.5}$ = coefficient to be studied.

ϵ_t = Error term

Diagnostic test for OLS:

1. Stationary Test.
2. Multicollinearity check.
3. Serial-correlation Test.
4. Heteroskedasticity Test.
5. Ramsey RESET
6. Newey-West Robust Errors.

Hypothesis Based on OLS Method:

H_1: Interest rate and Bitcoin have negative relationship.

When interest rate increases, it becomes more expensive to borrow money for the investors, which results in decrease in demand of speculative assets like bitcoin. Therefore, Bitcoin may generate negative returns when interest rate increases and vice-versa.

H_2 = Expected inflation and Bitcoin have positive relationship:

When expected inflation increases, the investor expects the decline in purchasing power of fiat currency, which leads to increase in demand of speculative and risky assets like Bitcoin. Therefore, the bitcoin gives positive returns.

H_3: Dollar and Bitcoin have negative relationship:

Increase in dollar shows, investors are buying fiat currency by selling their assets. Therefore, when dollar increases bitcoin tends to decline in value.

H_4: Money supply and Bitcoin has positive relationship:

When money supply increases, this shows economy is in expansion. This means that assets tend to generate positive return as increase in money supply increases liquidity.

H_5: Economic Policy Uncertainty and Bitcoin have negative relationship.

When EPU increases it shows market and economy may face negative impact which in return declines the Bitcoin return and vice-versa.

3.2.6Vector Auto-Regressive Model (VAR):

Model Specification:

Since one of our major objectives is to study and analyse the dynamic relationship between each variable or macro factors, we have use Vector-Autoregressive Model (VAR) in our study. The VAR model is used to analyse the dynamic relation in weekly timeseries data. Since VAR analyse all variables as endogenous and also allows for rich feedback and mechanism, we have decided to utilise VAR model in this study.

The VAR model for this study can be specified as:

Let the vector of the variable be:

$$Y_t = \begin{matrix} BTC \\ DXY \\ INF \\ Int. \\ EPU \\ MS \end{matrix}$$

Furthermore, the VAR model of order p VAR(p) can be:

$Y_t = c + A_1Y_1 + A_2Y_2 + \ldots\ldots\ldots A_pY_p + \epsilon_t$

Where, c denotes constant term vector, A_p represents the 6X6 matrices of coefficients that analyse the dynamic relation at lag p, Y_p represents and ϵ_t represents the 6X1 vector of error term. Furthermore, the error term needs to be white noise, should have zero mean.

Lag Selection:

One of the crucial and competitive process of Vector Autoregressive model is to select the lag length. The lag order should be selected carefully so that the model produces effective, stable and reliable coefficients from the model.

Since we have the weekly time series data, we have selected the lag length using multivariate information criteria which insures model fir. The criteria are as follows:

- Akaike Information Criterion (AIC)
- Schwarz Bayesian Criterion (BIC)
- Hannan Quinn Criterion (HIC)

Since we have tested p order from 1 to maximum lag order of 12, the best lag was selected after conducting AIC, BIC and HIC and the lag order with lowest AIC was selected for further process.

Granger Causality Test:

The Granger Causality Test was done in VAR to analyse the predictive power between each variable. Based on the selected lag order of VAR model, Granger Causality Test identifies the directional relationship.

In Granger Causality Test, in order to have Granger cause by X_t to Y_t , X_t must have statistically significant P-value that rejects the null hypothesis.

The null hypothesis expresses as:

$H_0 = \theta_1 = \theta_2 = \ldots \theta_p = 0$

Impulse Response Function:

When one variable experience one time shock, Impulse response function is used to observe how other variables responds. Under VAR, Impulse response function assists in capturing the pair wise dynamic interaction among all the variables.

Forecast Error Variance Decomposition:

In order to explain the variability of Bitcoin returns in relation to macro factors in weekly period under VAR, forecast error variance decomposition method is used.

<u>3.2.7 Auto Regressive Distributed Lag (ARDL):</u>

We have used ADRL model in our research to investigate the relationship between bitcoin returns and macro factors. We have used this model to analyse short term run equilibrium relationship between bitcoin and macro factors: expected inflation, interest rates, money supply, economic policy uncertainty. Since ARDL model incorporates distributed lags which helps in capturing the delayed effects of macro factors shocks on bitcoin returns which are normal and expected in financial markets because of delayed information transmission.

Model Specification:

The general model specification can be expressed as:

$$BTC_t = \alpha_0 + \sum_{i=1}^{p} \alpha i BTC_{t-I} + \sum_{j=0}^{q} \beta j\ \Delta INT_{t-j} + \sum_{k=0}^{pq} \gamma k\ \Delta INF_{t-k} + \sum_{l=0}^{q} \delta l\ \Delta DXY_{t-l} + \sum_{m=0}^{q} \Theta m\ \Delta EPU_{t-m} + \sum_{n=0}^{q} \phi n\ M2_{t-n} + \epsilon_t$$

Where,

Btc represents the bitcoin returns

INT_t represents interest rate

INF_t represents inflation rate

DXY_t represents dollar index

$M2_t$ represents money supply

EPU_t represents economic policy uncertainty index

$\epsilon_{t.}$ represents error term.

Estimation Procedure:

With the inclusion of lagged variables in Ordinary Least Square model to ensure

Consistent estimation of short run parameters, ARDL model is estimated. Based on the lowest value of AIC, lag selection is carried out to achieve the optimal balance in the model.

4. Empirical Research

4.1 Descriptive Statistics:

Table 1: Results from Descriptive statistics of all variables:

Statistic	Bitcoin	Dollar Index	EPU	Inflation	Interest Rate	Money Supply
Mean	190.7477	0.0319	0.545	0.00048	0.00709	18.5643
Std. Deviation	2759.6169	0.8446	45.7896	0.05275	0.09397	82.3447
Skewness	0.4816	0.2833	0.4621	0.0523	3.2083	-0.1398
Kurtosis	6.11	1.7883	5.0554	3.6063	35.2714	3.1306
Minimum	-12498.92	-2.5328	-200.26	-0.31	-0.59	-446.8
Maximum	13920.18	4.4986	219.62	0.29	0.75	419
Observations	561	561	561	561	561	561

The above table represents the descriptive statistics of bitcoin return and macro variables: dollar index, money supply, EPU, interest rate and inflation. We can see that; bitcoin has the highest mean and standard deviation among all the variables indicating that bitcoin has the highest volatility among all the factors. The minimum and maximum value of -12498.92 and 13920.18 shows the fluctuation in bitcoin price in a weekly period. The positive value of skewness and kurtosis indicates that likewise of traditional risky assets, bitcoin also has right tailed behaviour and fat-tails.

Meanwhile, the macro variable has very little volatility due to lower standard deviation compared to bitcoin return. Among the independent variable, dollar index and EPU shows moderate dispersion, inflation and interest rate has very small mean and variability, money supply has the largest variability among all the macro factors.

Except for the interest rate, all the independent variable has modest skewness.

4.2 Correlation Matrix:

Table 2: Results from Correlation Matrix between all variables:

	BTC	**DXY**	**EPU**	**INF**	**INT**	**M2**
BTC	1					
DXY	-0.1276	1				
EPU	-0.0977	0.0221	1			
INF	0.1353	-0.1720	-0.0768	1		
INT	-0.0670	-0.0957	-0.0935	-0.0295	1	
M2	-0.0035	0.0157	-0.0470	0.0242	-0.0907	1

The above table shows the correlation matrix between bitcoin returns and the macro factors: dollar index, EPU, Inflation, interest rate and Money supply. As we can observe, bitcoin has no strong correlation with macro factors suggesting a weak relationship with all the independent variables.

Regarding the relationship, bitcoin has only positive relationship with inflation. Furthermore, the relationship between inflation and bitcoin remains the strongest one among all the variables. This indicates that rising inflation leads to increase bitcoin returns. On the other hand, all the other macro factor has negative weak relationship with bitcoin returns, suggesting that rise in dollar index, EPU, interest rate and money supply leads to decline bitcoin returns.

Furthermore, within the independent variables, all the variables have weak relationship. However, correlation between dollar and inflation is the strongest one having negative relationship. This indicates that rising inflation declines the dollar index.

4.3 Augmented Dickey-Fuller Test:

Table 3: ADF Test Results

Variable	**ADF Statistic**	**P-Value**	**Stationary at 5%**
Btc	-6.8511	0.01	Yes
DXY	-7.5413	0.01	Yes
EPU	-8.1265	0.01	Yes
INF	-8.3222	0.01	Yes

INT	-4.9862	0.01	Yes
M2	-5.6954	0.01	Yes

The Augmented Dickey-Fuller test mostly used statistical tools to examine the presence of unit root in time-series data and consequently analyse the stationary of time series. Since, we are using OLS, VAR and ARDL models to examine the return of bitcoin in our report, it is very important to analyse the stationary of our time series data as our selected model demands the stationary assumptions. Furthermore, the non-stationary data are not qualified for the selected model and may lead to controversial regression results.

Since our original raw data were non-stationary, we conducted the first difference of our original data in order to make it stationary.

The above table represents the output of ADF test for analysing the stationary of time series data in our report. Based on the ADF test results all variables are stationary at significant level. The test statistic and p-value for all the variables shows the rejection of null hypothesis of a unit root.

4.4 Multicollinearity Test:

Table 4: Variance Inflation Factor results:

Variable	**VIF**	**Tolerance**
DXY	1.041516	0.9601390
EPU	1.018317	0.9820129
INF	1.039575	0.9619313
INT	1.029773	0.9710881
M2	1.011892	0.9882476

The above table shows the result from the multicollinearity test using Variance Inflation Factor. Based on the VIF results it can be clearly observed that multicollinearity is not a concern in our time series data. The VIF for all the variables ranges from 1.04 to 1.04 showing that the VIF output are highly lower than threshold value of 5 to 10. Since the VIF result is less than the threshold value it shows no multicollinearity issue in our data set.

The result shows that the coefficient in the models are stable and reliable and the standard errors are not inflated due to multicollinearity which clearly indicates that alternative hypothesis is rejected.

4.5 Heteroskedasticity Test:

Table 5: Regression Result with Robust Standard Errors.

Variable	Estimate	Robust Std. Error	t-value	p-value
Intercept	231.2922	114.1440	2.0263	0.0432
DXY	-376.1757	120.3329	-3.1261	0.0019
EPU	-5.7728	3.3896	-1.7031	0.0891
INF	5545.7966	2238.3555	2.4776	0.0135
INT	-2506.4038	1244.9514	-2.0133	0.0446
M2	-0.5538	1.3579	-0.4079	0.6835

Using BP Test including both the studentized version and Koenker-Bassett variant, as well as White test, heteroskedasticity test was conducted. The null hypothesis of homoscedasticity was rejected by the white test and studentized BP Test, which showed no evidence of heteroskedasticity. However, the Koenker-Bassett variant which is robust to departures from normality showed that the variance of the error term are not constant over time indicating the presence of heteroskedasticity.

Since we have the mixed results from the test, the study chose to use robust standard errors in all regression estimation. The robust standard error model shows that, several variables significantly influence bitcoin returns.

At 1%, DXY has the negative and statistically significant influence on bitcoin returns. Inflation on the other hand, positive and significant impact on bitcoin returns at 5% level. This finding shows that bitcoin might serve as a hedge asssets against rising inflation. Similarly, at 5% level, interest rate also has negative and statistically significant impact on bitcoin returns.

However, EPU is negative and has marginal effect and money supply does not have statistical effect on bitcoin returns.

4.6 <u>Ordinary Least Square:</u>

Under this section we are analysing the impact of macro factors on Bitcoin returns using Ordinary Least Square model. Since Bitcoin is traded worldwide and is volatile assets, its return is influenced by macro factors. OLS is the starting point of our empirical analysis since it helps to estimate the linear relationship between Bitcoin and independent variables.

Table 6: OLS Regression Results For Bitcoin Weekly Returns (Robust SE):

Variable	Estimate	Robust Std. Error	t-stat	P-value
Intercept	231.2922	113.5319	2.0372	0.0421
DXY	-376.1757	119.6877	-3.143	0.0018
EPU	-5.7728	3.3714	-1.7123	0.0874

INF	5545.7966	2226.3535	2.491	0.013
INT	-2506.4038	1238.276	-2.0241	0.0434
M2	-0.5538	1.3506	-0.4101	0.6819

Table 7: Model Statistics:

Statistic	Value
Observation	561
R^2	0.0442
Adjusted R^2	0.0356
Residual standard error	2710.1142
F-statistic	5.1289
P-value	0.0001

In our regression, we have five explanatory variables: dollar index, expected inflation, economic policy uncertainty index, interest rate and money supply. From the above table we can conclude that, the regression model estimated the output from 561 observations with R-squared of 4.4% respectively. Since the low value of R-squared shows that the model has modest explanatory power. Furthermore, this is normal for the assets like Bitcoin, since bitcoin is highly volatile and has high frequency financial returns. In our regression analysis the goal is to identify the meaningful relationship between Bitcoin and selected macro factors rather than studying all variations in returns.

Among all the variables included in our model, Dollar Index has the strongest relationship with Bitcoin. We can clearly say that dollar influence bitcoin the most among all variables. At 1% level, dollar is statistically significant with the coefficient of -376.1757. the negative coefficient indicates that, there exists a negative relationship between dollar and bitcoin. To explain it further, when dollar increases Bitcoin tends to decline in value and when dollar declines bitcoin tends to rise in value. In terms of value, when dollar increases by 1 unit bitcoin tends to fall by 376 units.

Among all the variables, inflation and bitcoin only has the positive relationship between them. The relationship statistically significant at 5% level with the coefficient of 5545.7966. The regression output suggests that rising inflation generates the highest Bitcoin returns among all the variables.

To conclude with, short term fluctuation in money supply do not impact bitcoin weekly returns since its coefficient is statistically insignificant. On the other side, economic policy uncertainty exhibits weak significant effect on bitcoin weekly return depicting lowest decline in bitcoin returns when economy worsens. Lastly, interest rate has significant negative relationship with bitcoin weekly returns.

The statistical result shoes that OLS model has captured valid relationship between Bitcoin and macro factors although, the R-square is low. However, R-square of 0.0442 is normal for financial return data especially for the speculative and volatile assets like Bitcoin. The adjusted R square of 0.0356 shows that model retains explanatory value after accounting the number of predictors.

F-static shows overall significance of the model. With the value of 5.1289 and its p-value of 0.001, this shows highly significant results meaning that our explanatory variables capture the non-random variation of Bitcoins return. At least one of the variables contribute meaningful relationship which rejects the null hypothesis that all coefficients are equal to zero.

Diagnostic Tests:

1. Multicollinearity:

Since the threshold value for Variance Inflation Factor (VIF) is between 5 to 10, however, our diagnostic test for OLS shows that VIF for all variables lies between 1.10 to 1.04. therefore, this low value clearly shows that the explanatory variables are not necessarily correlated with each other. This ensures that model does not deviate from instability and the co-efficient are valid with confidence.

2. Heteroskedasticity:

With an output of p-value of 0.1827 and statistic of 7.55 from Breusch-Pagan test, it clearly shows that null hypothesis of homoskedasticity cannot be rejected. This indicates that variance of all residuals are constant across different level of fitted plots. In addition, the error term does not expand or constant in relation to the predictors.

3. Autocorrelation:

The Durbin-Watson test generates the output of statistic 1.9568 with the p-value of 0.3046. This indicates that residuals do not suffer from autocorrelation, which means, residuals do no show systematic dependence from one week to another. This clearly shows, null hypothesis of autocorrelation cannot be rejected.

4. Normality:

Although all the assumptions of Ordinary Least Square were fulfilled and met, the Jarque-Bera test rejected the null hypothesis for normality of residuals. The test generated a large statistic of 807.40 with a p-value of 0.001which clearly shows that residuals deviate from the normal distribution.

However, to address this issue robust standard errors was applied throughout our analysis to ensure that the output remains valid although the null hypothesis for normality was rejected.

Conclusion:

In conclusion, the OLS analysis provided a meaningful result between the relationship between bitcoin and macro factors in our analysis. The result showed that, particularly Dollar Index, interest rate and expected inflation has the statistically significant effect on Bitcoin returns. This proves that, rather than being a isolated digital assets, Bitcoin is macro sensitive assets. Although the explanatory power of the model is low, this kind of output is acceptable for the speculative and volatile assets like Bitcoin.

Since, OLS model only provides the insight and knowledge of general relationship between macro factors and bitcoin, it does not fully capture dynamic interaction, lagged effect and long-run relationship. To address this issue the next section, consist of ARDL model which is specially used to analyse both the short term and long-term relationship between Bitcoin and macro factors.

4.7 Auto Regressive Distributed Lag (ARDL):

The Auto Regressive Distributed Lag (ARDL) analysis has given flexible and important empirical framework for studying how Bitcoin return is influenced by the fluctuations in macro variables across multiple time horizon. Here we have estimated an ARDL (2,4,1,0,0,0). The model includes 2 lags of Bitcoin, 4 lags of dollar index, 1 lag of economic policy uncertainty and 0 lags for expected inflation, interest rate and money supply. Both the theoretical priors and data driven selection are reflected by the lag structure showing that bitcoin responds quickly to some macro factors and not at all to some. The table below shows the ARDL (2,4,1,0,0,0) estimation results with Newey-West Robust Standard Errors.

Table 8: ARDL (2,4,1,0,0,0) estimation results with Newey-West Robust Standard Error.

Variable	**Coefficient**	**Robust SE**	**t-stat**	**p-value**	**Significance**
Intercept	218.51	110.65	1.975	0.0488	*

BTC (-1)	0.0231	0.0746	0.310	0.7568	
BTC(-2)	0.0178	0.0563	0.315	0.7527	
DXY	-392.70	133.28	-2.947	0.00335	**
DXY (-1)	65.65	119.40	0.550	0.5827	
DXY (-2)	-36.45	136.62	-0.267	0.7897	
DXY (-3)	47.56	104.78	0.454	0.6501	
DXY (-4)	106.14	112.78	0.941	0.3471	
EPU	-3.263	2.743	-1.190	0.2347	
EPU (-1)	9.687	3.923	2.469	0.0138	*
INF	5509.5	2295.6	2.400	0.0167	*
INT.	-1914.1	1207.1	-1.586	0.1134	
M2.	-1.1009	1.3729	-0.802	0.4230	

Observation	561
R-Square	0.0691
Adjusted R-Square	0.0485
F-static	3.364
P-value	<0.001

The coefficients of BTC (-1) and (-2) are very low: 0.023 and 0.018. this indicates that the value is statistically insignificant. In other words, once the macro factors are accounted for, Bitcoin past returns do not systematically assists in predicting the current returns. Bitcoin does not show strong autocorrelation at weekly time period unlike traditional assets like stocks. The analysis helps to generate important highlight that Bitcoin is limited to short run predictability. The findings show that there is an absence of significant momentum or mean reversion which explains that Bitcoin price moment is driven by contemporaneous shocks instead of driven by past patterns.

The most important finding from the above tables is Dollar Index coefficient. The efficient of -392.70 with t stat of -2.947 and p-value of 0.00335 is large and significant. This clearly shows the inverse relationship between dollar index and bitcoin returns. In other words, when dollar increases its value, bitcoin tends to generate negative returns. The magnitude further shows that, even in a weekly period when dollar increases by small number it generates substantial downward pressure on bitcoin returns. This can be linked to macro-financial theory, since bitcoin is traded in Dollar, stronger dollar means monetary tightening, decreased global liquidity which results in decreasing demand for speculative assets like bitcoin. However, none of the lag for Dollar Index coefficients are significant. This shows that Bitcoin return is impacted instantly rather than gradually when dollar strengthens.

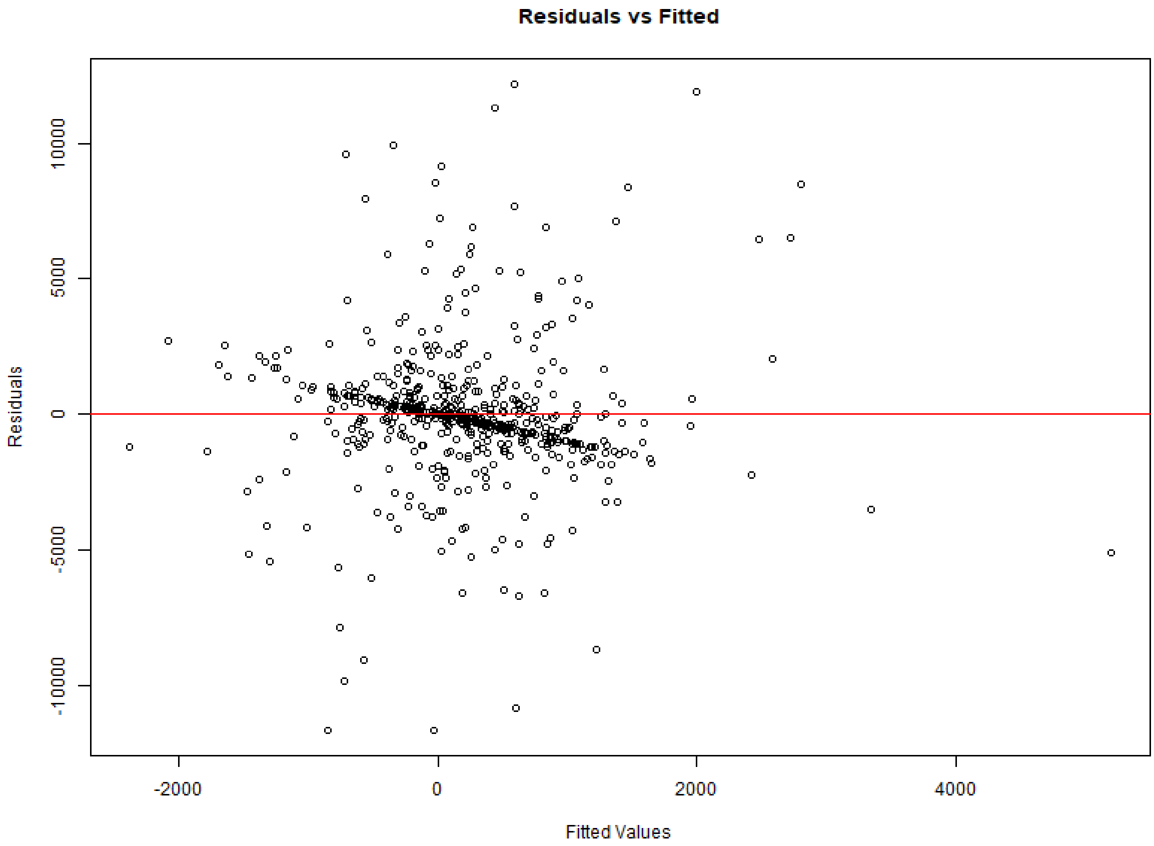
The instant effect of Economic Policy uncertainty on Bitcoin return is negative and insignificant is shown by coefficient of -3.263 and p-value of 0.235. However, with the coefficient of 9.687 and p-value of 0.0138, the lag value: EPU (-1) is positive and statistically significant. This indicates that Bitcoin reacts to economic policy uncertainty with a delay of one week rather than spontaneously. To make it simple, changes in economic policy takes time to impact Bitcoin returns. Furthermore, it can be seen that bitcoin generates positive returns when economic policy uncertainty rises.

Inflation, on the other hand can be seen as important predictor for Bitcoin returns, since the coefficient is 5509 with a p-value of 0.0167. This indicates that weekly increase in expected inflation contributes to positive bitcoin returns. This shows that, bitcoin can be regarded as hedge assets against the inflation.

Interest rate has a negative coefficient of -1914.1 with p-value of 0.1134 and money supply has the coefficient of -1.1009 and p-value of 0.4230. both the macro variables has negative impact on bitcoin, however the p- value suggest that, both factors are statistically insignificant.

Overall, regarding the model fit and accuracy, the adjusted R-square is low at 4.8%, This low number does not necessarily mean that the model is not meaningful. However, financial data are noisy and consists immediate and unexpected shocks and fluctuations. Therefore, this kind of result is typical for financial regression analysis. Also, the f-stat of 3.364 indicates that model is significant and despite of low persistence, the model explains the whole meaningful variation in Bitcoin returns.

Figure 3: Residuals vs Fitted values for ARDL(2,4,1,0,0,0)



The above figure represents the visual assessment of ARDL model. The residual in the above figure shows linear pattern, no clustering and no trends relative to the fitted values indicating that the functional value is valid and no transformation or nonlinear term is required. Although some wide spread of residuals value can be seen at extreme fitted levels, this is accepted in financial return modelling. The overall patters support that our ARDL (2,4,1,0,0,0) is valid and the diagnostics in the following section is suitable for deriving short run dynamics and long run equilibrium.

4.7.1 Error Correction Model: Short Run Dynamic:

With the adequacy of ARDL (2,4,1,0,0,0) in the above chapter, here, in this section we will discuss the short run dynamic and adjustment mechanism through Error Correction Model. The ECM explains the bitcoins behaviour in two components:

- How bitcoin behaves to change in weekly macro factors in short run
- The speed at which deviations from long run equilibrium are corrected.

4.7.2 ECM Derived From ARDL (2,4,1,0,0,0)

Table 9: ECM From ARDL(2,4,1,0,0,0)

Variable	**Coefficient**	**Std. er.**	**t-stat**	**p-value**	**Sig.**
ECT (-1)	-0.9591	0.0606	-15.84	<0.001	***
ΔBTC (-1)	-0.0178	0.0429	-0.413	0.6794	
ΔDXY	-392.7	138.9	-2.827	0.00486	**
ΔDXY(-1)	-117.2	238.3	-0.492	0.6230	
ΔDXY(-2)	-153.7	193.1	-0.796	0.4265	
ΔDXY(-3)	-106.1	135.9	-0.781	0.4352	
ΔEPU	-3.264	2.658	-1.228	0.2201	
INF	5509.5	2.223	2.478	0.0135	*
INT	-1914.1	1.246	-1.536	0.1252	
M2	-1.101	1.415	-0.778	0.4368	

Error Correction Term is the most crucial coefficient in the above ECM table. The coefficient for ECT is -0.9591 with a p-value of <0.001which is large in magnitude. This means that within one week 96% of any deviation from long run equilibrium is corrected. In financial econometric this kind of adjustment is rare, which indicates that when macro factors shift, bitcoin returns equilibrate instantly. The finding challenges the concept that bitcoin is purely speculative assets and sentiment driven. Rather, it says that, although bitcoin experience short term volatility, over the long horizon it is still anchored to macro factors.

The ΔDXY has the coefficient of -392.7 and p-value of 0.00486. this indicates that even a small appraisal in dollar leads to huge decline in bitcoin returns during the same week period. However, none of the lagged DXY are significant which means bitcoin reacts immediately to dollar fluctuations with no delayed or persistent effect.

On the other hand, hand, inflation can be seen as critical determinate in the short run. With the coefficient of 5509.5 and p-value of 0.0135, it suggests that higher expected inflation increases bitcoin returns. This further supports the idea of bitcoin as a hedge asset against the inflation. The magnitude of coefficient indicates that bitcoin is highly sensitive towards the inflation.

Although Economic policy uncertainty was significant but only with lag in ARDL model in the previous table, here in ECM contemporaneous change in the economic policy uncertainty is negative but insignificant. This shows that EPU does not immediately affect the bitcoin returns rather it takes time to influence returns.

The interest rate has the coefficient of -1914.1 and p-value of 0.125. this shows that, although there exists the negative relationship between bitcoin returns and interest rate, the relationship is statistically not significant. Since interest rate changes barely, also the investors and market participant forecasts the interest rate early, interest rate influence on bitcoin returns more in a long term structural sense.

Money supply shows insignificant short run influence with coefficient of -1.101 and p- value of 0.437.

Table 10: Long-Run Relationship from ECM:

Variable	**Long-run coefficient**
DXY	218.7
EPU	-6.70
INF	-5746
INT	1995
M2	1.15
intercept	-227.7

The above table show the long-run coefficient derived from ARDL (2,4,1,0,0,0) which explains how Bitcoin reacts to persistent macro factors shift once all the short run shocks have dissipated. The long run coefficient for Dollar is 218.7, which means that when dollar strengths Bitcoin tends to increase its long run value. Although bitcoin and dollar is viewed as substitute as per the traditional theories, empirical studies have shown some other findings. Empirical studies have shown that bitcoin and dollar have regime dependent and time varying relationship. When the dollar was rising during the sample period, the global financial conditions might had been improved at the same time. This positive aspect could rise the demand for bitcoin. This is the reason why bitcoin and dollar moved in the same direction in the long run.

Economic policy uncertainty on the other hand exhibits a negative long run relationship with the coefficient of -6.70. it shows that when the economic policy uncertainty index rises, meaning that when the investor expects negative policies, it reduces long term demand for Bitcoin.

Inflation shows important and huge magnitude of negative effect with the coefficient of -5746. Despite of seeing bitcoin as the hedge against inflation, empirical findings have mostly shown that rising inflation supresses the demand for speculative assets. The large negative coefficient of inflation shows that when inflation rises bitcoin tends to decline its long-term value.

The interest rate shows a positive effect on Bitcoin long term value. Furthermore, rising interest rate is associated with higher bitcoin value in the long run. Conversely, with money supply there exists a small but positive influence.

The long run intercept of -227.7 shows that when all the macro factors together are 0, the value of bitcoin in the long run is -227.7. Overall, the model shows that bitcoin is not detached from the macro factors.

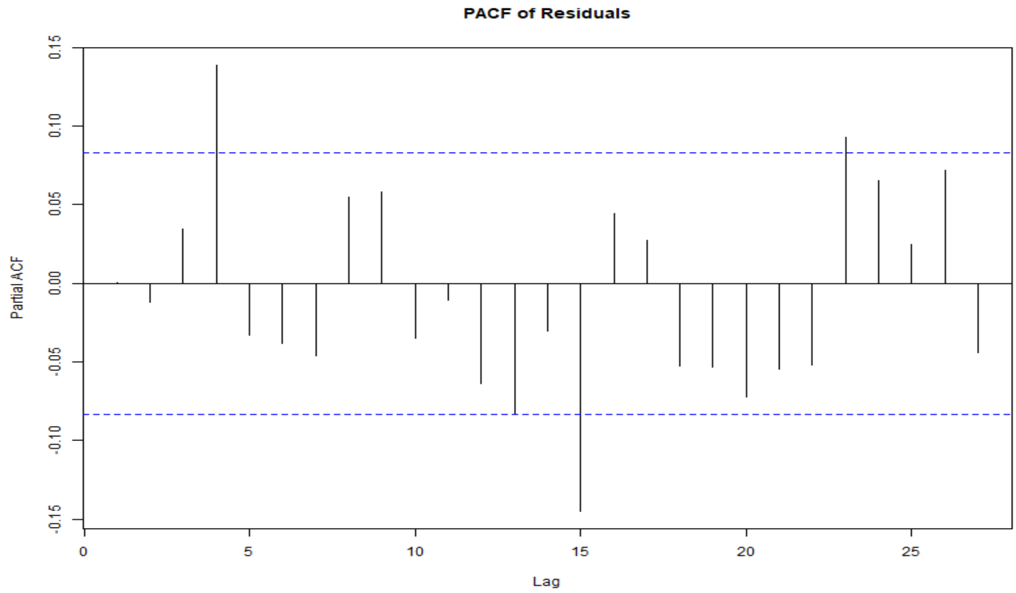
4.7.3 Diagnostic Test For ARDL:

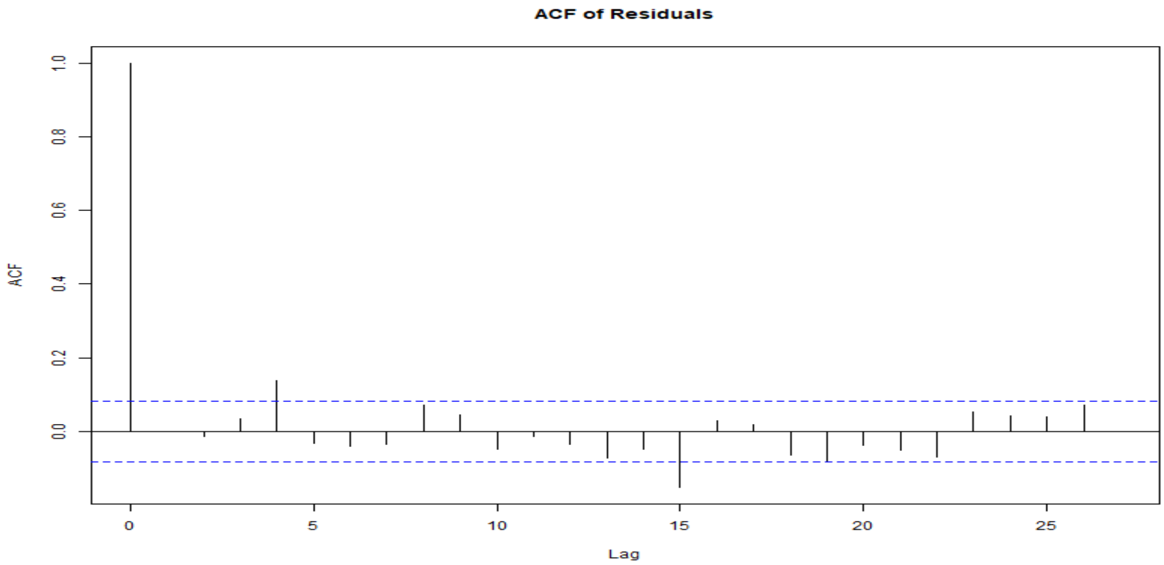
In order to verify, assess the adequacy and reliability of ARDL (2,4,1,0,0,0) we have conducted the ARDL model diagnostic test as well. This diagnostic test helps to check whether the key assumptions of the ARDL model are fulfilled or violated.

1. Serial Correlation:

To check the serial correlation, we have applied Breusch- Godfrey Test. We have obtained the LM static of 13.53, df of 4 and p-value of 0.008955. The test result shows the presence of serial autocorrelation. Therefore, we have applied Newey-west robust Standard Error to ensure the validity of model.

Figure 4: PACF and ACF of Residuals.





2. Heteroskedasticity:

BP static: 21.866 df:12 P-value:0.03905

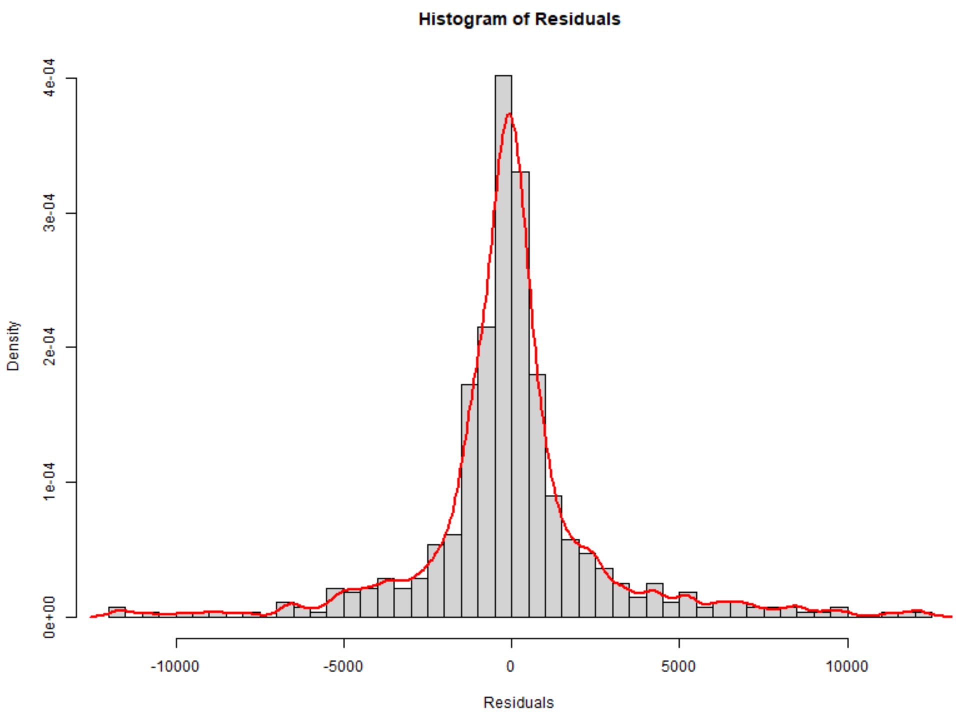
To check the heteroskedasticity we have used Breusch-Pagan test. Since the above data shows slightly lower p-value, it shows the presence of mild heteroskedasticity. Therefore, Newey-west robust Standard Error corrected both autocorrelation and heteroskedasticity.

3. Normality:

JB Static: 654.18 df: 2 p-value: <2.2e-16

The above test result shows residuals are deviated from Normality. Therefore, normality of residuals does not hold in ARDL model. However, normality is not essential for ARDL model.

Figure 5: Histogram of Residuals.



4. Functional Form:

Reset F statistic: 1.0072 df1: 2, df2: 542 p-value: 0.3659

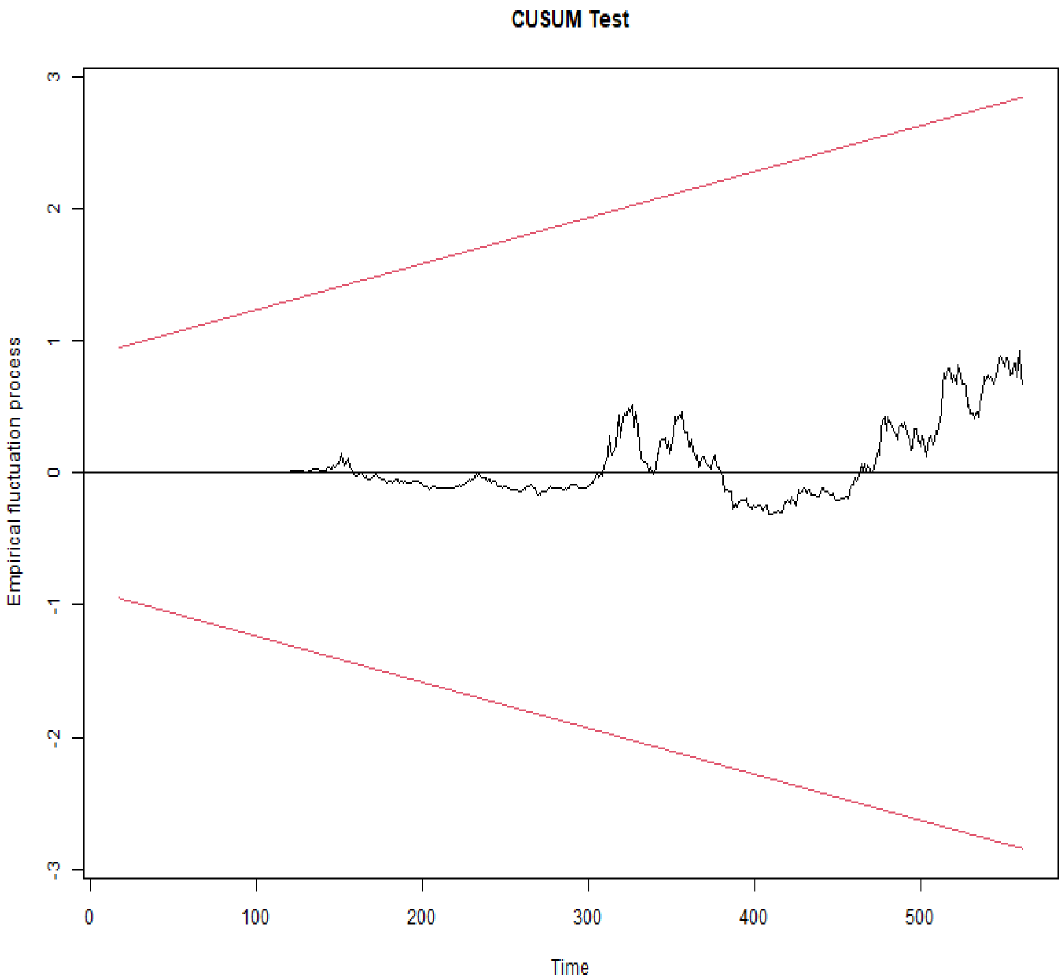
To check the functional form, we have conducted Ramsey Reset test. Since the p-value is significantly higher than 0.05, the null hypothesis of functional form is not rejected. Therefore, the test shows the model is well specified and no non-linear transformation is needed.

5. Structural Stability:

S Statistic: 0.30871 P-value: 0.9543

The test for structural stability was done using CUSUM test. With the p-value significantly higher than 0.05, the test shows that ARDL parameters are stable.

Figure 6: CUSUM Test



4.8 Vector Auto Regression (VAR):

In thi section we discuss the oputput generated from VAR model to show the joint dynamic relatonship between multiple variables used in our study. In other words we examine how shock in one variable is spread and its influence on other varibale.

The VAR model was used as a foundation for several other analytical tools that are used to study the dynamic relationship further such as granger causality test, impulse responsive function and forecast error variance decomposition. These analytical tools guide us to examine the directional relationship, magnitude, and duration of response and show the importanc eof each variable in interpreting the forecast movement.

Lag Selection Criteria:

This section privides the methods used to select the criteria based on AIC, BIC, HQ and FPE. Below is the complete table that represents the value of AIC, BIC, HQ and FPE and the value of these components from lag 1 to lag 12.

Table 11: Lag Selection Criteria for VAR

Lag	**AIC**	**HQ**	**BIC**	**FPE**
1	21.19823	21.32704	21.52781	1.60797e+09
2	21.11673	21.35594	21.72881	1.48218e+09
3	21.12716	21.47677	22.02174	1.49790e+09
4	20.90083	21.36085	22.20779	1.19476e+09
5	20.91603	21.48645	22.37560	1.21347e+09
6	**20.62116**	21.30199	22.36323	9.04044e+08
7	20.66722	21.45845	22.69179	9.47319e+08
8	20.67039	21.57202	22.97745	9.51208e+08
9	20.65265	21.66469	23.24222	9.35601e+08
10	20.69746	21.81990	23.56952	9.79924e+08
11	20.75009	21.98329	23.90465	1.03475e+09
12	20.81355	22.15681	24.25061	1.10494e+09

From the above table, the lag 6 provided the minimum AIC and FPE value indicating that lag 6 privides best balance between goodness of fit and predictive accuracy for the dynamic relationship between bitcoin and macro factors. Although BIC and HQ provides best goodness of fit and predictive accuracy at lag 8, choosing lag 8 might cost increasing the number of parametres in high dimesnsional VAR model. However, the most important criteria is to fulfill all stability requirements, roots of polynomial lying within the unit circle and all dynamic responses are well behave and are suitable for impulse response and variance decomposition analysis. While all there criteria are statisfies by VAR(6). Therefore, we have selected lag 6 for our VAR model estimation.

4.8.1 VAR Estimation:

VAR Estimation : Bitcoin Equation:

Table 12: VAR estimates for Bitcoin equation:

Coefficient	Estimate	Std. Error	t-value	p-value
btc.l1	0.04262	0.04458	0.956	0.33957
DXY.l1	69.44881	146.700	0.473	0.63615
EPU.l1	12.38464	2.97395	4.164	0.0000366
INF.l1	-649.08715	2357	-0.275	0.78310
INT.l1	-324.59152	1302	-0.249	0.80318
M2.l1	-0.98864	1.79685	-0.550	0.58241
BTC.l2	0.006162	0.04569	0.135	0.89277
DXY.l2	-137.90947	148.20751	-0.931	0.35254
EPU.l2	3.90522	3.24362	1.204	0.22915
INF.l2	582.06462	2361.375	0.246	0.80540
INT.l2	342.66847	1310.409	0.261	0.79381
M2.l2	-0.07364	1.79898	-0.041	0.96736
BTC.l3	0.03660	0.04665	0.785	0.43304
DXY.l3	-56.16494	147.91161	-0.380	0.70431
EPU.l3	4.57055	3.40070	1.344	0.17954
INF.l3	-1398.98377	2402.72491	-0.582	0.56065
INT.l3	-1122.60484	1325.47929	-0.847	0.39742
M2.l3	1.00720	1.57699	0.639	0.52331
BTC.l4	0.16489	0.04685	3.520	0.00047***
DXY.l4	194.98207	148.72511	1.311	0.19043
EPU.l4	-2.19592	3.38760	-0.648	0.51713
INF.l4	724.72122	2399.22412	0.302	0.76272
INT.l4	1463.88739	1340.65850	1.092	0.27538
M2.l4	0.36620	1.57303	0.233	0.81601

BTC.l5	-0.02761	0.04752	-0.581	0.56152
DXY.l5	-5.70222	146.61347	-0.039	0.96899
EPU.l5	-0.20222	3.24814	-0.062	0.95038
INF.l5	2640.51871	2403.00790	1.099	0.27235
INT.l5	64.53637	1340.76503	0.048	0.96163
M2.l5	0.36898	1.74021	0.212	0.83216
BTC.l6	-0.05448	0.04778	-1.140	0.25471
DXY.l6	96.07705	144.77476	0.664	0.50722
EPU.l6	-5.35142	2.99135	-1.789	0.07420
INF.l6	-1077.93333	2390.45074	-0.451	0.65223
INT.l6	-1855.56887	1342.06584	-1.383	0.16738
M2.l6	0.82345	1.74153	0.473	0.63653
const	127.87594	142.44530	0.898	0.36975

The above bitcoin equation table from VAR(6) shows that, among bitcoin's own lag, only BTC_{t-4} has statistically significant coeffecient. With the estimate of 0.16489 and p-value of 0.00047, it shows meaningful rise in current bitcoin return assocoated with a positive shock in four period earlier. This data further shows Bitcoin return dynamic has medium term persistence . In addition to that it further shows market shock do not disspaear quickly but continue to influence return several period ahead.

However, the coeffecient on btc_{t-5} and btc $_{t-6}$ are negative but are statistically insignificant. With estimate of -0.02761 and -0.05448, and p-value of 0.56152 and 0.25471, both the coefficient suggests mean-reversion. Since the coefficients are statistically insignificant such adjustment mechanism cannot be empirically confirmed based on the model. The first three lag of bitcoin indicates that bitcoin does not immediately react to very recent price, the reliable autoregressive effect emerges at longer horizon.

The overall finding suggest that bitcoin lacks short run autoregressive feedback, rather it consists medium term persistence effect. Since the data shows significance at lag 4 and insignificance at other lags, it underscores the appropriateness of including multiple lags in VAR specification since the lower lag would fail to capture the delayed dynamic response.

From the VAR (6) of Bitcoin equation, the only statistically significant macro factor is Economic Policy uncertainty index (EPU). At lag 1, EPU has the statistically significant coefficient indicating that rise in EPU at earlier period leads ton increase Bitcoin return currently. This also shows that Bitcoin responds immediately to EPU. Furthermore, all other remaining variable do not transmit the shock in Bitcoin returns since they are all statistically insignificant.

VAR Estimation : Dollar Equation:

From the VAR equation of dollar, although Bitcoin, inflation, EPU, money supply shows no statistically significant coefficient. Overall the result shows that, interest rate is gthe inly major factor that drives dollar index.

With regards to bitcoin, across all the lags bitcoin has statisctically insignificant coffecients. There results shows that bitcoin returns do not have meaningful relationship with respect to dollar index since the estimated coeffecioents are extremely small and shows no persistent. With in the analyzed short and medium time period, bitcoin is mostly independent from fiat currency.

None of the coeffecients are statisctically significant for dollar index own lags. This suggest that rather than by its oen past values, dollar index is mostly drived by interest rates because there is a lack of strong autoregressive effect.

Also, EPU has also insignificant coeffecient across its own lag. At larger lags EPU has negative coeffecient although they are not significant . This indicates that change in EPU do not directly predict the movement in dollar index.

In addition, inflation also has statistcailly insignificant impact on dollar index. Although inflation has positive coeffecioent across most lags, they are almost near to zero. This shows inflation aklone cannot change dollar index, it should be supported by other policies as well, most importantly interest rate.

Surprisingly, since all the factors have insignificant coeffecients, interest rate is the most dominant explanatory variable in the VAR structure. The first lag of interest rate shows negative relationship between interest rate and dollar index with large negative and statictically significant coeffecient. Howver, when the lag is increased to third, it has positive statistically significant coeffecient. This shows dollar may react differently in short term which differ from medium term reaction.

VAR Estimation: EPU Equation:

Except Bitcoin, all macro factors has dynamic effect n Economic policy uncertanity Index. Since lag 1, lag 2 and lag 6 has significant negative coeffecient, EPU has strong autoregressive mean reversion characters. This further indicates that, EPU tends to correct downward for subsequent weeks after the uncertanity index rises, which returns towards long run equilibrium.

Dollar Index has the large and highly significant positive effect on EPU at lag 1. This makes Dollar Index strongest macro factors to influence EPU. This shows when dollar rises, EPU tends to rise next week immediately.

Furthermore, inflation has negative significant coefficient at lag 1 and lag 2. The data shows when inflation rises, Economic uncrtanity index tends to decline in short run. However, at higher lags inflation becomes statistically insignificant.

Meanwhile, the at lag 3 interest rate has negative coeffecient and is statistically significant. The data shows interest rate impact uncertanity with a delay meaing that increasing interest rate declines EPU after several weeks. Likewise, money supply shows same characters at lag 6.

On the flip side, bitcoin shows no signifucant effect at any lag.

VAR Estimation: Inflation Equation:

The inflation equation table shows only few significant factors shoiwing meaningful effects. The output further shows short run inflation dynamics are relatively stable. Money supply is the onky consistent macro factor that has positive effects at lag 1 and lag 6. The data shows money supply has both immediate and with delay effect which further depicts that increase in money supply increase inflation.

Meanwhile, dollar influence is only significant at lag 3. The negative coeffecient shows that, when dollar rises, it generally has short run negative impact on inflation.

However, the other factor do not exhibit signifucant influence on inflation.

VAR Estimation: Interest Rate Equation:

The VAR equation from interest rate shows meaningful spillover and autiregressive characters. With a large positive coeffecient from own lag of interesr rate at lag 6, it is the most significant driver with statistically strong p-value. This shows that interest rate adjust slowly with substantial persistence. Also, inflation at lag 2 influence interest rate which further suggest that when inflation rises it influence interest rate with delay.

Bitcoin on the other hand has no significant impact on interest rate. Although EPU shows limited influence, dollar rate does not show significant impact on interest rate on short run.

VAR Estimation: money supply Equation:

The equation for money supply shows strongest pattern of autoregressive nature. The output shows that money supply is influenced by its own past values and few macro factors. At lag 3, lag 4 and lag 6, money supply has strong coeffecient.

On the other hand interest rate at lag 2, lag 5 and lag 6 shows statistically significant negative effect on money supply. This shows that rising interest rate decreases money supply growth. In addition to that, EPU and Bitcoin shows statistically positive effect on money supply at lag 2, meaing that rising EPU and bitcoin returns increases money supply to inject liquidity in the market. Lastly, inflation significantly reduces money supply at lag 4.

4.8.2 Granger Causality Test:

Table 13: Granger Causality Test Results:

Causal Direction	**Null Hypothesis**	**p-value**
EPU → BTC	Rejected	< 0.05
DXY → BTC	Not Rejected	> 0.05
INF → BTC	Not Rejected	> 0.05
INT → BTC	Not Rejected	> 0.05
M2 → BTC	Not Rejected	> 0.05
BTC → EPU	Not Rejected	> 0.05
BTC → DXY	Not Rejected	> 0.05
BTC → INF	Not Rejected	> 0.05
BTC → INT	Not Rejected	> 0.05
BTC → M2	Not Rejected	> 0.05

The above table shows the result generated from Granger Causality Test obtained from VAR(6). The result shows that there is undirectional predictive relationship from EPU to bitcoin returns. Furthermore, it shows that, EPU contains useful information in predicting the bitcoin returns since the null hypotheisis of no Granger Cause is rejected. Bitcoin does responds to the EPU shocks and may act as hedge during periods of uncertanity.

However, the null hypothesis for all other factors at VAR(6) is not rejected. This suggest that, dollar index, interest rate, inflation and money supply do not cause any significant Garnger cause. Therefore, it can be interpreted that, there is an absense of reverse casuality which primarily indicated that Bitcoin works as a shock reciever rather than a shock transmitter within the macro factors.

4.8.3 Impulse Response Function:

Table 14: IRF Test:

Impulse Shock	Response Variable	Direction of Response	Peak Horizon	Persistence
EPU	BTC	Positive	Short-run (1–2 periods)	Temporary
BTC	BTC	Positive	Immediate	Short-lived
DXY	BTC	Insignificant	—	—
INT	DXY	Positive	Medium-run (3–4 periods)	Moderate
INT	M2	Negative	Medium-run	Persistent
INF	INT	Positive	Medium-run	Temporary
BTC	Macro Variables	Insignificant	—	—

The above table shows the Impulse Response Functions data generated from VAR(6) model. The dats shows that EPU shocks has positive direction of response toward Bitcoin returns that last temporarily for just 1-2 periods. This indicates that rising EPU increase Bitcoin returns for short run indicating Bitcoin as hedge assets during rising policy uncertanity.

Bitcoin on the other hand, has positive direction response towards its own returns. Howver, this response is short lived. This indicates that cryptocurrencey market is highly volatile and has rapid adjustment. However, bitcoin shocks generally generate insignificant impact towards macro factors.

From the above table, interest rate seems to be the major role playing factor. A tightening shock in interest rates results in positive response to the dollar index and a persistent decline in growth of money supply. Overall it can be observed that, macro factors plays an impactful role toward bitcoin returns. Hoever, bitcoin do not generate any influence towards macro factors.

4.8.4 Forecast Error Variance Decomposition (FEVD):

Table 15: FEVED Results:

Variable	**Horizon**	**BTC**	**Dollar**	**EPU**	**Inflation**	**Interest**	**Money**
BTC	1	100.0	0.0	0.0	0.0	0.0	0.0
BTC	8	94.12	0.73	3.69	0.63	0.7	0.13
BTC	12	94.02	0.74	3.69	0.64	0.75	0.17
DXY	1	2.12	97.88	0.0	0.0	0.0	0.0
DXY	8	3.19	91.77	0.34	0.43	2.92	1.35
DXY	12	3.2	91.34	0.35	0.45	3.22	1.45
EPU	1	0.52	0.1	99.38	0.0	0.0	0.0
EPU	8	1.72	3.06	89.74	3.04	1.01	1.43
EPU	12	1.78	3.05	89.11	3.09	1.08	1.88
INF	1	1.81	2.55	0.02	95.63	0.0	0.0
INF	8	3.02	3.52	1.61	88.73	0.82	2.3
INF	12	3.04	3.52	1.62	88.24	0.96	2.62
INT	1	0.05	0.83	1.22	0.01	97.91	0.0
INT	8	1.61	1.45	2.06	1.96	92.5	0.41
INT	12	1.73	1.55	2.06	2.19	91.95	0.52
M2	1	0.1	0.0	0.01	0.0	0.33	99.55
M2	8	1.32	1.35	2.44	2.84	7.26	84.8
M2	12	1.29	1.52	2.64	3.18	7.78	83.6

The above table shows the output generated from Forecast Error Variance Decomposition from VAR(6). It provides importance of shocks in explaining the forecast error variance decomposition of each variable at short, medium and long horizon. Every macro factors and bitcoin are explained by their own lag at horizon

1. At horizon 1, Bitcoin FEVDs at lag 1 is 100%, suggesting that bitcoin's forecast error variance is self-driven. At lag 1, macro factors do not exert any immediate influence. Only few percentage of variance decomosition can be observed at 1% for other macro factors too. However, they are also self-driven like bitcoin at horizin 1.

At horizon 8, spillover effect can be seen getting more effectively. 94.12% of variance is driven by bitcoin itself at medium horizon. EPU has the highest percentage at 3.69% for explaining bitcoin variance decomposition. At horizin 8, for dollar index, interest rate contribute at 2.92% for variance decomposition, showing that interest rate is the major factor among all. Meanwhile, EPU is slighly senssitive towards dollar index and inflation.

The patter gets even more stronger at horizon 12. Bitcoin at horizon 12 still remains self driven at 94.02% wigth EPU becoming the most impacting forces at 3.69%. At every horizon, interest rate is the most impacting force for money supply with variance decomposition of 0.33% at horizon 1, 7.26% and 7.78% at horizon 8 and 12.

Overall, the data shows that bitcoin performs as shock absorber rather than shock transmitter.

4.8.5 Diagonistic Checek For VAR Model:

Table 16: Diagonistic check results:

Diagnostic Test	**Test Statistic**	**p-value**	**Conclusion**
Stability (Roots of VAR)	Max root = 0.9407	Not applicable	Stable VAR
Serial Correlation (Portmanteau)	$\chi^2 = 511.01$	2.66×10^{-7}	Reject H_0
Heteroskedasticity (ARCH LM)	$\chi^2 = 3626.7$	$< 2.2 \times 10^{-16}$	Reject H_0
Normality (Jarque–Bera)	$\chi^2 = 13,734$	$< 2.2 \times 10^{-16}$	Reject H_0

The table above shows the diagnostic test results from VAR model in order to examine its adequacy and reliability. Firstly, with maximum root less than 1 we satsifies the stablity assumptuion of VAR model. This shows that the the shock explained by the model decays over time rather than producing explosive behaviour. Therefore, this further supports the stability and validity of IRF and FEVD result derived from the model.

However, the other assumption are not satisfied by the model. The portmanteau test fro examining serial correlation rejects the null hypotheisi of no serial correlation. Furthermore, ARCH LM test also rejects the null hypothesis of no heteroskedasticity, indicating that there exists a volatility clustering.

Lastly, jarque-bera test also rejects the null hypothesisi of normality of residuals.

5. Conclusion:

This thesis studies how bitcoin return is affected by macro variables: dollar index, money supply, Interest rate, inflation and economic policy uncertainty index. We have further studies, the dynamic relation between all the variables, and short run and long run dynamics as well. To analyse these areas we have used Ordinary Least Square (OLS), Vector Auto-Regressive Model (VAR) and Auto-Regressive Distributed Lag (ARDL) model in our study. By using all the models, we have found that Bitcoin does respect to macro factors, in fact, it behaves as macro sensitive assets and the return’s fluctuation is based on the liquidity regime, and most importantly, bitcoin is highly affected by monetary policy factors.

From the correlation matrix results we have found that among all the macro variables only inflation has the positive relation to bitcoin, while all the other macro factors have negative relationship. The correlation matrix alone does not show the full picture; inflation remains the strongest macro factors at descriptive level.

More complex and deeper relation is generated from Ordinary Least Square model with robust standard errors. The OLS captured inflation, dollar and interest rate as statistically major determinants of bitcoin returns. Fluctuations in the dollar index has the highest impact on bitcoin returns indicating that when the dollar rises, bitcoin tends to decline its return. Inflation on the other hand has large and positive relation to bitcoin returns. It further supports that bitcoin can work as a hedge asset against rising inflation in order to save purchasing power of money. Consistent with the ideas that, rising interest rate declines bitcoin return, OLS shows statistically significant relationship between interest rate and bitcoin returns since, rising interest shows tighter monetary condition which declines the demand for speculative and risky assets like Bitcoin. Lastly, economic policy uncertainty index and money supply has weak and insignificant relationship with bitcoin returns.

In addition, the short run and long run equilibrium was studied using ARDL model in our research. Bitcoin, in the short run, matches with the findings from OLS for inflation and dollar index. Similar to OLS, ARDL also shows that bitcoin reacts quickly to decline in dollar value and positively to rise in inflation level. With regards to economic policy uncertainty index, Bitcoin reacts with one week delay as information transmission takes time to impact the returns for bitcoin. For the short run error correction term, it is large, highly significant and negative, suggesting that, all the short-term deviation from long term equilibrium are corrected with in a week.

However, the long run equilibrium shows more complex results. There is a negative long term effect for inflation and economic policy uncertainty index. However, on the other side, positive long run is associated for interest rate and money supply. These results shows that, although when inflation increases for long period, it can supress bitcoin returns. This shows bitcoin has dual nature as speculative assets and macro sensitive assets.

From the VAR model, since the first three lag of bitcoin returns are statistically insignificant this shows that it is impossible to predict Bitcoins return at weekly period using recent past returns. However, the lag fourth is statistically significant showing the existence of medium-term persistence.

With respect to macro variables, economic policy uncertainty index, the first few are insignificant, however the later lags are marginally significant. This shows that economic policy uncertainty index takes time to influence Bitcoin returns.

Regarding dollar index, the findings contradict from OLS and ARDL model since the coefficients across all the lags are mixed and statistically insignificant. This suggests that dollar index has high impact in a single equation models rather than dynamic channels.

Overall, the VAR model shows that, bitcoin is macro sensitive assets, through dynamic transmission channel, macro factors influence bitcoin returns and most importantly, to capture Bitcoin's medium-term dynamic it is evident to use larger lags as shorter VAR specification would fail to capture it.

6. Relevant to Past Studies:

This study was conducted studying the existing past literatures. Overall, the findings from our analysis are also almost similar to the existing past references. This further fills the gap of time horizon as most of the cited and studies literature were studied only until 2022.

Firstly, the prior research supported our major finding that there exists a negative relationship between dollar index and bitcoin return which was generated from OLS, VAR and ARDL model. Many referred literatures showed the similar finding that, when dollar rises its value, it shows tighten monetary policy, which reduce the risk bearing capacity of the investors decreasing the demand of speculative assets like bitcoin. Since, our findings says that, bitcoin reacts quickly to dollar movements also matches with the existing literatures suggesting that exchange rate and liquidity shocks transit quickly to cryptocurrency market. However, VAR treats all the variables as endogenous, the model shows that the effect diffuses, which also matches with literatures focusing on system-wide interaction instead of single channel.

Secondly, many past literatures have found that bitcoin tends to increase its return when inflation is expected to rise, particularly when investors fear inflation accompanied by monetary policy. This also matched with our finding of short-run impact of expected inflation on bitcoin returns. However, the from the ARDL mode, inflation has negative coefficient in long-run equilibrium. This finding matches with other studies as well showing that bitcoin fails to perform as hedge against persistent inflation. However, this mixed and dual results clearly show the mixed conclusion as well.

The OLS result showing negative relationship between bitcoin and interest rate also matches with prior research. This finding corresponds with the assets-pricing theory as well. Many researchers have found that rising interest rate increases the borrowing cost showing monetary tightening which results in low demand for bitcoin. However, on the other hand, ARDL and VAR model shows interest rate as fewer influencing factors. Although, this is also supported by the prior research because interest rates are often predicted by markets and incorporated gradually rather than viewing it as immediate or discrete shocks.

Finally, from the ARDL model, bitcoin to economic policy uncertainty index has delayed response. This closely supports to behavioural theory. Many researchers in the past have shown that uncertainty does not affect bitcoin quickly rather, it affects with a lag as investors calculate risk and rebalance the portfolio.

Overall, although the findings of this research contradict with past literatures in some prospects, it does matches with prior literature in some factors as well. It further provides strong strengths to a growing scope of study that bitcoin is macro sensitive in conditional manner, time-varying and is strongly affected by monetary factors.

6. Importance of This Research:

This research contributes meaningful relationship between macro variables and bitcoin return. By using correlation analysis, OLS, VAR and ARDL model it provides valuable knowledge for investors, policymakers and graduates researchers alike which studies multidimensional understanding of bitcoin return dynamics.

To the investors, this research paper helps in portfolio allocation and risk management. Since the result shows bitcoin behaves as macro sensitive assets rather than self-driven assets. Especially, interest rates, inflation and dollar index highly impact bitcoin returns. This means that, investor should highly monitor interest rates, inflation and dollar index and manage their portfolio according to the macro factors fluctuations. The dollar index and interest rate has the strong negative relation to bitcoin. This shows that bitcoin tends to decline its return during monetary tightening. Alternatively, bitcoin reacts positively to increasing inflation in short run. This shows that bitcoin works as hedge against inflation that protects investors capital.

Regarding the policy makers, this research shows bitcoin is deeply connected to macro factors. Although bitcoin transaction is not directly linked to central bank control, this research and prior research has found that, bitcoin is highly sensitive and affected by interest rate, dollar rate and inflation. Since, many people says bitcoin is different from traditional assets and is not affected by monetary factors, this research challenges the concept of bitcoin being different from traditional assets. Policy makers can use these findings to understand and analyse how monetary tightening and monetary easing can influence bitcoin return and investor behaviour. Policymakers, rather than making many restrictions in cryptocurrencies market, policy makers should focus on making bitcoin as an integral part of broader financial ecosystems, especially during economic stress,

For the graduates alike, this research shows, for a highly volatile assets like bitcoin, it is important to adopt multi-model approach. Combining OLS, VAR and ARDL give deep insight into the impact of macro factors on bitcoin returns highlighting that single model would fail to capture delayed effects and dynamic relationship. Furthermore, this research also helps graduates to show the general relationship between macro factors and bitcoin returns.

8. Limitations of the Study:

Although we have studied the relationship between bitcoin returns and macro factors and provided many important insigts between m,acro factors and bitcoin, this reseacrh apepr several limitations as well. Alalysing these linitations is also an important aspect for placing the findings in proper context and for the future guidance as well.

Firstly, this report uses weekly data to analyse the reseacrh objectives. Since weekly data captures the medium term effcets more precisely, these data can not fully reflect bitcoin,s high frequencey dynamics. Bitcoin is traded 24 hours for 365 days in a year and it also reacts rapidly to news, sentiments, and speculative trading activity. Although, weekly data clears out noise and high volatility they also smooth out important short-term reactions.

Secondly, instead of logarithmic or percentage returns for analysing the itcoin returns, we have used dirst differenced of raw data with bitcoin and money supply measured in dollars, economic policy uncertanity index and dollar index are measured in respective index values and interest rate and inflation as percentage. Though the first diffenceing of raw price or data has ensured the stationary of our time series, it makes difficult to compare the coeffecients with the existing prior researches since, most of the prior research used log returns. Furthermore, the choice of selected macro factors are not exhaustive. This research excludes several other important macro factors such as Volatility index (VIX) of equity index. The ommission of such variable may generate omitted variable bias results since bitcoin may be senstitive towards equity market as well.

Another major disadvantage of this reasearch is choice of Emperical model. Since we are using OLS, VAR and ARDL, these model are linear framework and fails to capture non-linear, asymmetric, time dependent relationshiop between bitcoin and amcro factors. Since many prior reseacrh shows bitcoin return response differetly dependeing up on bull and bear periods, monetary stress and mionetary easing.

Importantly, although, robust standards error methods has been used, some of the diagonistic tests still fails. For example, even after using robust standard errors methods, the residuals are not normally distributed, shows mild heteroskedasticity, especially in OLS and ARDL model.

APPENDIX:

Appendix 1: Heteroskedasticity test:

Test	**Test Statistic**	**df**	**p-value**	**Conclusion**
Studentized Breusch–Pagan	7.5515	5	0.1827	No heteroskedasticity
Koenker–Bassett BP	29.4330	5	0.0000	Heteroskedasticity detected
White Test	0.7992	2	0.6706	No heteroskedasticity

Appendix 2: Phillips-Ouliaris Cointegration Test:

Statistic	**Value**	**Significance Level**
Test Statistic (Pu)	617.39	-
Critical Value	50.35	10%
Critical Value	57.79	5%
Critical Value	76.77	1%

Appendix 3: ARDL Coefficient Non-Robust

Variable	**Estimate**	**Std. Error**	**t-value**	**p-value**
Intercept	218.5	118.8	1.839	0.0665
L(btc,1)	0.0231	0.0424	0.544	0.5863
L(btc,2)	0.0178	0.0429	0.413	0.6794
Dxy	-392.7	138.9	-2.827	0.00486 **
L(DXY,1)	Xy	138.3	0.475	0.6353
L(DXY,2)	-36.45	138.3	-0.264	0.7922
L(DXY,3)	47.56	136.4	0.349	0.7274
L(DXY,4)	106.1	135.9	0.781	0.4352
EPU	-3.264	2.658	-1.228	0.2201
L(EPU,1)	9.687	2.669	3.630	0.00031 ***
INF	5509	2223	2.478	0.01351 *
INT	-1914	1246	-1.536	0.1252
M2	-1.101	1.415	-0.778	0.4368

Model Statistics:

Residual standard error: 2701

R-squared: 0.0691

Adjusted R-squared: 0.0486

F-statistic: 3.364 on 12 and 544 df (p = 9.39e−05)

Appendix 4: UECM Representation:

Variable	Estimate	Std. Error	t-value	p-value
Intercept	218.5	118.8	1.839	0.0665
L(btc,1) (ECT)	-0.9591	0.0606	-15.837	< 2e-16 ***
L(DXY,1)	-209.8	307	-0.683	0.4947
L(EPU,1)	6.424	4.267	1.506	0.1328
INF	5509	2223	2.478	0.0135 *
INT	-1914	1246	-1.536	0.1252
M2	-1.101	1.415	-0.778	0.4367
ΔBTC(-1)	-0.0178	0.0429	-0.413	0.6794
ΔDXY	-392.7	138.9	-2.827	0.00486 **
ΔDXY(-1)	-117.2	238.3	-0.492	0.6230
ΔDXY(-2)	-153.7	193.1	-0.796	0.4265
ΔDXY(-3)	-106.1	135.9	-0.781	0.4352
ΔEPU	-3.264	2.658	-1.228	0.2201

Model Statistics:

Residual standard error: 2701

R-squared: 0.5261

Adjusted R-squared: 0.5157

F-statistic: 50.33 (p < 2.2e−16)

Appendix 5: Diagnostic Test for ARDL Model (Non-Robust):

Test	Statistic	df	p-value
Breusch–Godfrey (Serial Correlation)	13.53	4	0.008955
Breusch–Pagan (Heteroskedasticity)	21.866	12	0.03905
Jarque–Bera (Normality)	654.18	2	< 2.2e−16
RESET (Functional Form)	1.0072	2, 542	0.3659
CUSUM Stability Test	S = 0.30871	—	0.9543

Appendix 6: VAR for Dollar Index:

Coefficient	Estimate	Std. Error	t-value	p-value
BTC.l1	0.000005	0.000014	0.370	0.71181
DXYl1	-0.009945	0.045060	-0.221	0.82541
EPU.l1	0.000166	0.000913	0.181	0.85610
INF.l1	0.462200	0.723800	0.639	0.52340
INT.l1	-1.290000	0.399800	-3.226	0.00134
M2.l1	-0.000907	0.000552	-1.644	0.10074
BTC.l2	0.000015	0.000014	1.081	0.28022
DXY.l2	0.000237	0.045520	0.005	0.99585
EPU.l2	0.000385	0.000996	0.386	0.69958
INF.l2	0.686000	0.725200	0.946	0.34463
INT.l2	0.635600	0.402500	1.579	0.11489
M2.l2	-0.000126	0.000553	-0.228	0.82001
BTC.l3	-0.000008	0.000014	-0.577	0.56445
DXY.l3	0.010050	0.045430	0.221	0.82495
EPU.l3	-0.000813	0.001044	-0.778	0.43671
INF.l3	0.609900	0.737900	0.826	0.40891
INT.l3	-0.919600	0.407100	-2.259	0.02429
M2.l3	-0.000746	0.000484	-1.540	0.12406
BTC.l4	-0.000018	0.000014	-1.245	0.21356
DXY.l4	0.035700	0.045680	0.782	0.43473
EPU.l4	-0.001104	0.001040	-1.061	0.28927
INF.l4	0.667600	0.736800	0.906	0.36531
INT.l4	0.270700	0.411700	0.657	0.51119
M2.l4	-0.000777	0.000483	-1.609	0.10827

BTC.l5	0.000011	0.000015	0.737	0.46129
DXY.l5	0.042540	0.045030	0.945	0.34524
EPU.l5	0.000239	0.000998	0.240	0.81047
INF.l5	0.062870	0.738000	0.085	0.93215
INT.l5	-0.184200	0.411800	-0.447	0.65479
M2.l5	0.000169	0.000534	0.315	0.75263
BTC.l6	0.000013	0.000015	0.861	0.38988
DXY.l6	0.057800	0.044460	1.300	0.19421
EPU.l6	-0.000571	0.000919	-0.621	0.53479
INF.l6	0.116700	0.734200	0.159	0.87377
INT.l6	-0.686400	0.412200	-1.666	0.09648
M2.l6	-0.000614	0.000535	-1.148	0.25141
const	0.091540	0.043750	2.092	0.03689

Appendix 7: VAR Equation for EPU

Coefficient	Estimate	Std_Error	t_value	p_value
btc.l1	-0.000207	0.000651	-0.318	0.75051
DXY.l1	7.525032	2.141528	3.514	0.00048
EPU.l1	-0.425938	0.043411	-9.812	0
INF.l1	-103.99904	34.401143	-3.023	0.00263
INT.l1	-12.075472	19.000632	-0.636	0.52536
M2.l1	0.007141	0.026229	0.272	0.78552
BTC.l2	-0.001699	0.000667	-2.548	0.01112
DXY.l2	-0.149251	2.163388	-0.069	0.94502
EPU.l2	-0.31509	0.047347	-6.655	0
INF.l2	-137.147436	34.469035	-3.979	8e-05

INT.l2	-28.871479	19.128069	-1.509	0.13181
M2.l2	0.013137	0.02626	0.5	0.61709
BTC.l3	-0.000588	0.000681	-0.863	0.38869
DXY.l3	1.124889	2.159068	0.521	0.60258
EPU.l3	-0.089939	0.04964	-1.812	0.07059
INF.l3	-55.530788	35.072617	-1.583	0.11396
INT.l3	-42.103963	19.348044	-2.176	0.03
M2.l3	0.011569	0.023019	0.503	0.61546
BTC.l4	-0.000566	0.000684	-0.828	0.40809
DXY.l4	-0.254998	2.170943	-0.117	0.90654
EPU.l4	0.029974	0.049449	0.606	0.54467
INF.l4	6.849035	35.021516	0.196	0.84503
INT.l4	-3.433219	19.569616	-0.175	0.86081
M2.l4	0.01151	0.022962	0.501	0.6164
btc.l5	-0.001073	0.000694	-1.548	0.12235
DXY.l5	2.985958	2.140119	1.395	0.16354
EPU.l5	0.050092	0.047413	1.057	0.29123
INF.l5	12.33965	35.076748	0.352	0.72514
INT.l5	-34.362524	19.571171	-1.756	0.07972
M2.l5	-0.045546	0.025402	-1.793	0.07355
btc.l6	-0.00017	0.000697	-0.243	0.8079
DXY.l6	2.183496	2.11328	1.033	0.30198
EPU.l6	-0.151698	0.043665	-3.474	0.00056
INF.l6	-33.683905	34.893451	-0.965	0.33483
INT.l6	-30.462239	19.590158	-1.555	0.12056
M2.l6	-0.085461	0.025421	-3.362	0.00083

const	4.41631	2.079277	2.124	0.03415

Appendix 8: VAR Equation for Inflation

Coefficient	**Estimate**	**Std_Error**	**t_value**	**p_value**
btc.l1	1e-06	1e-06	0.667	0.50509
DXY.l1	0.000229	0.002772	0.083	0.93405
EPU.l1	6.7e-05	5.6e-05	1.201	0.23044
INF.l1	0.078817	0.044528	1.77	0.0773
INT.l1	-0.012565	0.024594	-0.511	0.60965
M2.l1	6.9e-05	3.4e-05	2.041	0.04179
BTC.l2	0.0	1e-06	0.154	0.87728
DXY.l2	-0.002323	0.0028	-0.83	0.4072
EPU.l2	0.000114	6.1e-05	1.868	0.06231
INF.l2	-0.059709	0.044615	-1.338	0.18139
INT.l2	0.009453	0.024759	0.382	0.70277
M2l2	2.2e-05	3.4e-05	0.655	0.51289
btc.l3	-1e-06	1e-06	-1.411	0.15883
DXY.l3	-0.006693	0.002795	-2.395	0.01698
EPU.l3	3.8e-05	6.4e-05	0.59	0.55524
INF.l3	-0.034724	0.045397	-0.765	0.44468
INT.l3	0.029071	0.025043	1.161	0.24625
M2.l3	7e-06	3e-05	0.225	0.82183
btc.l4	1e-06	1e-06	1.546	0.12267
DXY.l4	0.001704	0.00281	0.606	0.54457
EPU.l4	-9e-06	6.4e-05	-0.135	0.89274
INF.l4	-0.041385	0.045331	-0.913	0.36168

INT.l4	-0.020643	0.02533	-0.815	0.41548
M2.l4	3.4e-05	3e-05	1.142	0.25386
btc.l5	1e-06	1e-06	1.391	0.16487
DXY.l5	-0.002454	0.00277	-0.886	0.37615
EPU.l5	-7e-06	6.1e-05	-0.122	0.9031
INF.l5	-0.019071	0.045402	-0.42	0.67462
INT.l5	0.042192	0.025332	1.666	0.09641
M2.l5	-4.4e-05	3.3e-05	-1.349	0.17783
btc.l6	1e-06	1e-06	1.061	0.28916
DXY.l6	0.002168	0.002735	0.792	0.42844
EPU.l6	6.8e-05	5.7e-05	1.203	0.22953
INF.l6	0.002479	0.045165	0.055	0.95624
INT.l6	-0.003079	0.025357	-0.121	0.9034
M2.l6	8.9e-05	3.3e-05	2.692	0.00732
const	-0.003832	0.002691	-1.424	0.15512

Appendix 9: VAR Equation for Interest Rate:

Coefficient	**Estimate**	**Std_Error**	**t_value**	**p_value**
btc.l1	-2e-06	1e-06	-1.72	0.08607
DXY.l1	-0.003476	0.004578	-0.759	0.44804
EPU.l1	-0.000177	9.3e-05	-1.907	0.05709
INF.l1	0.051748	0.073538	0.704	0.48194
INT.l1	0.051459	0.040617	1.267	0.20575
M2.l1	-5.2e-05	5.6e-05	-0.931	0.35248
btc.l2	0.0	1e-06	0.198	0.84326
DXY.l2	0.002226	0.004625	0.481	0.63049

EPU.l2	2.5e-05	0.000101	0.249	0.80354
INF.l2	0.165782	0.073683	2.25	0.02487
INT.l2	0.039365	0.040889	0.963	0.33614
M2.l2	1.3e-05	5.6e-05	0.228	0.81953
btc.l3	1e-06	1e-06	0.568	0.57007
DXY.l3	0.005578	0.004615	1.209	0.22737
EPU.l3	-0.000126	0.000106	-1.188	0.23547
INF.l3	0.123964	0.074974	1.653	0.09885
INT.l3	0.021668	0.04136	0.524	0.60058
M2.l3	1.6e-05	4.9e-05	0.326	0.74431
btc.l4	1e-06	1e-06	0.607	0.54438
DXY.l4	-0.003295	0.004641	-0.71	0.47805
EPU.l4	-5.5e-05	0.000106	-0.522	0.60211
INF.l4	0.029173	0.074864	0.39	0.69693
INT.l4	-0.020355	0.041833	-0.487	0.62676
M2.l4	4.7e-05	4.9e-05	0.952	0.34174
btc.l5	-3e-06	1e-06	-2.004	0.04555
DXY.l5	0.006264	0.004575	1.369	0.1715
EPU.l5	-7.3e-05	0.000101	-0.72	0.47179
INF.l5	-0.019307	0.074982	-0.257	0.79691
INT.l5	-0.041223	0.041837	-0.985	0.32492
M2.l5	3.1e-05	5.4e-05	0.568	0.57021
btc.l6	-1e-06	1e-06	-0.701	0.4838
DXY.l6	0.003165	0.004517	0.701	0.48391
EPU.l6	0.000128	9.3e-05	1.372	0.17059
INF.l6	0.024679	0.074591	0.331	0.74088

INT.l6	0.430655	0.041877	10.284	0.0
M2.l6	-3.7e-05	5.4e-05	-0.69	0.49048
const	0.003754	0.004445	0.845	0.39871

Appendix 10: VAR Equation for Money Supply:

Coefficient	Estimate	Std_Error	t_value	p_value
btc.l1	-0.000593	0.001016	-0.584	0.55972
DXY.l1	1.623642	3.344744	0.485	0.62758
EPU.l1	0.115974	0.067801	1.711	0.08777
INFl1	2.914707	53.729397	0.054	0.95676
INT.l1	-50.095039	29.676122	-1.688	0.092
M2.l1	0.109451	0.040965	2.672	0.00778
btc.l2	0.002335	0.001042	2.242	0.02541
DXY.l2	-4.046812	3.378885	-1.198	0.23159
EPU.l2	0.191328	0.073949	2.587	0.00994
INF.l2	-40.163908	53.835433	-0.746	0.45598
INT.l2	-89.87884	29.875158	-3.008	0.00275
M2.l2	0.14512	0.041014	3.538	0.00044
btc.l3	-0.001435	0.001064	-1.35	0.17773
DXY.l3	5.905247	3.372139	1.751	0.08051
EPU.l3	-0.066742	0.07753	-0.861	0.38972
INF.l3	24.638931	54.778138	0.45	0.65305
INT.l3	-16.504785	30.218727	-0.546	0.58518
M2.l3	-0.275647	0.035953	-7.667	0.0
btc.l4	0.001274	0.001068	1.193	0.23356
DXY.l4	3.021026	3.390686	0.891	0.37335

EPU.l4	0.006009	0.077232	0.078	0.93802
INF.l4	-163.556834	54.698326	-2.99	0.00292
INT.l4	-10.535043	30.564788	-0.345	0.73048
M2.l4	0.445537	0.035863	12.423	0.0
btc.l5	0.000579	0.001083	0.535	0.59311
DXY.l5	-5.850894	3.342544	-1.75	0.08064
EPU.l5	-0.056154	0.074052	-0.758	0.44861
INF.l5	-67.35911	54.78459	-1.23	0.21943
INT.l5	-106.692676	30.567216	-3.49	0.00052
M2.l5	0.124905	0.039674	3.148	0.00174
btc.l6	0.000163	0.001089	0.149	0.8813
DXY.l6	3.146383	3.300624	0.953	0.3409
EPU.l6	0.030916	0.068198	0.453	0.65051
INF.l6	-58.009681	54.498308	-1.064	0.28763
INT.l6	-97.619504	30.596873	-3.191	0.00151
M2.l6	-0.330871	0.039704	-8.333	0.0
const	16.747241	3.247516	5.157	0.0

References:

https://en.wikipedia.org/wiki/Bitcoin#:~:text=Based%20on%20a%20free%2Dmarket,of%20its%20open%2Dsource%20implementation.

https://www.forbes.com/sites/digital-assets/article/the-history-of-bitcoin-who-invented-it/

https://www.fortunebusinessinsights.com/industry-reports/cryptocurrency-market-100149

https://curvo.eu/backtest/en/market-index/bitcoin?currency=eur

https://bpb-us-w2.wpmucdn.com/voices.uchicago.edu/dist/7/1291/files/2017/01/reaching_for_yield_published.pdf?utm_source=chatgpt.com

https://www.nber.org/system/files/working_papers/w10449/w10449.pdf

file:///C:/Users/bhatt/OneDrive/Desktop/complaints/ssrn-282915.pdf

https://link.springer.com/content/pdf/10.1186/s40854-021-00274-w.pdf

Aharon, D. Y., Umar, Z., & Vo, X. V. (2021). Dynamic spillovers between the term structure of interest rates, Bitcoin, and safe-haven currencies. Financial Innovation.

Baur, D. G., Hong, K., & Lee, A. D. (2021). Bitcoin: Medium of exchange or speculative assets? Journal of International Financial Markets, Institutions and Money.

Corbet, S., Larkin, C., & Lucey, B. (2020). The impact of macroeconomic news on Bitcoin returns. Finance Research Letters.

Kristoufek, L. (2020). On the interplay between Bitcoin and interest rates. Physica A: Statistical Mechanics and Its Applications.

Smales, L. A. (2019). Bitcoin as a safe haven: Is it even worth considering? Finance Research Letters.

Karau, S. (2023). Monetary policy and Bitcoin. Applied Economics Letters.

Baur, D. G., & Dimpfl, T. (2023). Liquidity conditions and cryptocurrency volatility. Journal of International Financial Markets, Institutions and Money.

Blau, B. M., Griffith, T. G., & Whitby, R. J. (2021). Inflation and Bitcoin: A descriptive time-series analysis. Economics Letters.

Bouri, E., Corbet, S., & Lucey, B. (2021). Bitcoin and inflation hedging: A wavelet coherence approach. Finance Research Letters.

Cheema, M. A., & Faff, R. W. (2023). Behavioral dynamics of risk-seeking and inflation hedging in cryptocurrency markets. Journal of Behavioral Finance.

Conlon, T., Corbet, S., & McGee, R. (2022). Are cryptocurrencies inflation hedges? Evidence from VAR analysis. Journal of International Financial Markets, Institutions and Money.

Cong, L. W., Ghosh, P., & Li, J. (2024). Inflation expectations and cryptocurrency investment. NBER Working Paper No. 32945.

Dyhrberg, A. H. (2016). Bitcoin, gold, and the dollar—A GARCH volatility analysis. Finance Research Letters.

Kristoufek, L. (2020). On the interplay between Bitcoin and macro-financial variables. Physica A: Statistical Mechanics and Its Applications.

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. Journal of Financial Economics.

Umar, Z., Aharon, D. Y., & Vo, X. V. (2023). Inflation expectations, monetary tightening, and cryptocurrency volatility. Applied Economics Letters.

Ahmadova, L., Guliyev, A., & Aliyev, S. (2023). Cointegration among Bitcoin, the U.S. Dollar Index, Nasdaq, and commodities: Evidence from FMOLS, DOLS, and CCR models. International Journal of Energy Economics and Policy.

Aliu, F., Asllani, A., & Hašková, S. (2023). Dynamic interactions between Bitcoin, the dollar index, and volatility indicators: Evidence from VAR and SVAR models. Studies in Economics and Finance.

Journal of Risk and Financial Management (2025). Time–frequency coherence between Bitcoin, the U.S. Dollar Index, and global assets (2015–2024).

Frontiers in Blockchain (2025). The long-term nexus between the U.S. Dollar Index, gold, and Bitcoin: Evidence from cointegration and volatility modeling.

Akhtaruzzaman, M., Sensoy, A., & Corbet, S. (2022). The influence of consumer confidence on cryptocurrency returns and volatility. Journal of Behavioral Finance.

Balcilar, M., Bouri, E., Gupta, R., & Roubaud, D. (2017). Can volume predict Bitcoin returns and volatility? A quantiles-based approach. Economic Modelling.

Bouri, E., Lucey, B., & Roubaud, D. (2023). Macro determinants of Bitcoin returns and volatility: The role of monetary policy and confidence. Finance Research Letters.

Fisher, K. L., & Statman, M. (2003). Consumer confidence and stock returns. Journal of Portfolio Management.

Shahzad, S. J. H., Bouri, E., Roubaud, D., & Kristoufek, L. (2023). Time-varying connectedness between consumer sentiment and cryptocurrency markets. Economic Systems.

Smales, L. A. (2021). Investor fear and the cryptocurrency market. Research in International Business and Finance.

Shiller, R. J. (2019). Narrative Economics: How Stories Go Viral and Drive Major Economic Events. Princeton University Press.

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty.

Bouri, E., et al. (2017). Does Bitcoin hedge global uncertainty? Finance Research Letters.

Corbet, S., Larkin, C., & Lucey, B. (2020). The impact of macroeconomic news on Bitcoin returns. Finance Research Letters.

Kristoufek, L. (2020). On the interplay between Bitcoin and macro-financial variables. Physica A.

Liu, Y., & Tsyvinski, A. (2021). Risks and returns of cryptocurrency. Journal of Financial Economics.

Smales, L. A. (2021). Investor fear and the cryptocurrency market. Research in International Business and Finance.Wu, C., Huang, Y., & Lin, W. C. (2023). Economic sentiment, uncertainty, and the volatility of cryptocurrencies. Finance Research Letters.

Diebold, F. X., & Yilmaz, K. (2012). On the measurement of spillover effects. Journal of Econometrics.