

IS BITCOIN THE DIGITAL GOLD?: A VECM MODEL APPROACH

BY  
LIN YU CHEN

THESIS

Submitted in partial fulfillment of the requirements for the degree of  
Bachelor of Arts in Economics in the Department of Economics of Waseda University, 2021

Tokyo, Japan

Advisor:  
Professor Michiko Ueda

## **ABSTRACT**

Bitcoin and gold share more similarities than differences. On the supply side, both assets are mineable - mining and ownership is decentralized; and unlike traditional currencies, their supply cannot be artificially pumped by fiat or monetary policy. On the demand side, both are considered hedges against inflation and have merits as a store of value. Thus, bitcoin is often honored with the title as the “digital gold” due to their similarities. In this study, a VECM model will be applied for both bitcoin & gold, then the results will be compared to observe whether bitcoin has similar characteristics with gold and how they respond to major macroeconomic variables to determine whether bitcoin is the real “digital gold”. According to data analyzed in this paper, it was concluded that gold has not been a reliable hedge against inflation during the sample period of this study (2015/02 - 2021/11). Furthermore, the safe-haven asset showed positive correlation with the USD in recent years. Bitcoin, on the other hand, did not reveal much correlation with inflation, and therefore, cannot be considered a well-established inflation hedge. However, this was not the case with the USD, as the cryptocurrency seemed to hold merit as a hedge against USD volatility. Despite the fact that Bitcoin’s increase in price seemed to have little to do with inflation, this does not imply that it is completely deprived of the potential as a hedge against inflation in the future. Indeed, with ever growing mainstream adoption and public acceptance, one can speculate that Bitcoin could be the next digital gold.

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## **CHAPTER I**

### **Introduction**

Inflation has surged in 2021 by the most in nearly four decades, to be accurate, 39 years. According to the U.S Bureau of Labor Statistics, the consumer price index has soared by 7% in 2021, making it the largest 12-month gain since 1982 (Bureau of Labor Statistics, 2021). The current level of inflation is exceptionally high as we consider that the Federal Reserve usually aims to run under their 2% goal of the annual inflation rate. This all started when COVID-19 first devastated the global economy in March 2020 as major cities around the world went into lockdowns, businesses were forced to close, consumer demand collapsed as consumers mostly stayed at home to stay away from the deadly virus, and the unemployment rate even skyrocketed to an all-time high at 14.70 percent. A global recession could have possibly occurred after the downturn of events; instead, the economy took a V-shape rebound as the Federal Reserve initiated its asset purchasing program, cutting interest rates, and dedicated to creating a quantitative easing environment. As the result, consumers were able to build up their savings from their time in lockdowns as well as multiple stimulus checks provided by the government sending consumer demand to unprecedented levels. On the other side, the emergence of new COVID-19 variants, Delta and Omicron, further disrupt the already weak supply chain by worsening existing issues such as lack of workforce, global freight bottleneck, chip shortage, etc. These factors combined contributed to setting up the stage for the high inflationary economic environment as of now.

Gold has always been considered as one of the strongest hedges against inflation. By nature, gold is a precious metal that does not corrode with a limited amount of supply, providing a sustainable store of value since ancient times. The U.S monetary system was based on the gold

standard not until the U.S government adopted fiat money in 1973, proving the status of gold as an asset that holds intrinsic value. Gold has earned itself the reputation as an inflation hedge by its long-term historic performance during inflationary moments, as investors believe that the value of gold holds up better while the value of currencies gets eroded by price hikes. Thus, gold is often considered as a conviction play that improves returns while reducing risks in the long run. On the other side, Bitcoin, which is often referred to as digital gold, is the hybrid of fiat and commodity currencies. It is the first and the largest digital currency in the world which uses blockchain technology to create a decentralized ledger that allows users to skip intermediaries for transactions. Similar to gold, bitcoin can be acquired in the process of "mining" which miners can put new bitcoin into circulation by solving extremely complicated math questions. Moreover, Bitcoin's durability, scarcity, and other different characteristics have drawn the interest of investors and scholars into comparing it with prestigious gold. Despite the current Bitcoin price moves purely on speculation, the market has seen sizable institutional capital pouring into the cryptocurrency market in 2021 as the public is now more familiarized with the concept of digital assets like Bitcoin and starts to see the true intrinsic value behind them. The massive expansion of the crypto market over the past few years has also led governments around the world to work on a regulatory framework to stabilize the current global financial system, and to provide protection to the investors in these widely fluctuated assets.

Under the inflationary theme in 2021, Bitcoin had been testing all-time highs continuously, recording an astounding 57.3% annual return despite experiencing a 31.5% price drop to end the year. On the other side, gold surprisingly recorded a negative 7.1%. Many may argue the price surge of Bitcoin was the beneficiary of excess stimulus cash from the public and that Bitcoin hasn't proved itself to have a meaningful correlation with the inflation rate as the

Federal Reserve repeatedly claimed inflation to be "transitory" throughout 2021. Nonetheless, with the abovementioned characteristics and the foreseeable stability of the "digital gold", Bitcoin has the potential to step up as an alternative of gold as a strong hedge against inflation moving toward the future.

In this paper, a VECM model will be applied for both bitcoin & gold, then the results will be compared to see whether bitcoin has similar characteristics with gold and how they react to major macroeconomic variables that are proved to be correlated with gold such as inflation rate, fed funds rate, USD currency index, etc. in the model. The following section discusses the review of past studies on the proposed title of this paper. In Section 3, the data used in the study will be presented and the rationale behind the picks of macroeconomic variables that will be applied in the VECM model will be explained. Finally, Section 4 performs the result of the VECM model with IRFs (Impulsive Response Function) and Forecast Error Variance Decompositions (FEVD) of both bitcoin and gold, followed by a brief discussion and conclusion.

## CHAPTER II

### Literature Review

As an investment asset, the notion that gold serves as a safe haven during times of high inflation and economic turmoil is deep-rooted in the minds of investors. To date, numerous studies that adopted various methodologies across different time horizons have established the general consensus that gold consistently exhibits a negative correlation with stock market volatility and currency depreciation.

According to a study that utilized wavelet analysis that compared the U.S., the U.K., and Germany's stock and bond indices, gold acted as a hedge for equities and debt market investments for horizons of up to one year; during financial crisis, the same property is more pronounced (Bredin et al., 2015) .Another study based on multivariate dynamic copula theory proposed that *gold is an effective and robust hedge against the depreciation value of the currencies* (Nguyen et al., 2020).

In discussing gold's correlation with unemployment figures, a paper elucidated its positive correlation, justified by as much as *4.7% for every 1% change in the unemployment rate* during 2008-2016 in one (Model III) of its three models that revealed the strongest relationship based on Pesaran's (2001) Bounds Test (Thaver and Lopez, 2016). Model II which takes into account data from 1990-2016 also revealed *a long run relationship* in the same direction as Model III, albeit to a relative weaker extent. Model I (1978-2016) did not observe such relationship for a longer timeframe. Overall, this study implies a stronger relationship between gold and unemployment data in more recent decades.

In adjunct to this, another paper found that investor sentiment showing *extreme fear (confidence)* contributes to positive (negative) volatility jumps in gold returns (Balciilar et al.,

2017). These findings have significant implications to how risk and pricing should be assessed when confronting negative (positive) economic sentiment trackers.

Whereas gold has lived up to its reputation as a safe investment during economic predicaments, some have argued that Bitcoin, a nascent asset class, exhibit the same property as gold and has piqued the interests of investors as an alternative to it. Assets such as equities and bonds depend heavily on FOMC as it has a direct impact on the future macroeconomic environment. However, Pyo and Lee (2019) indicated that the federal macroeconomic announcement does not show a direct impact on bitcoin's price movement.

Dubbed as the ‘virtual gold’, a study applying the asymmetric GARCH methodology and utilizing data from 2010 – 2015 found bitcoin to be an obvious hedge against stocks. In addition, it was proven to be a hedge against the U.S. dollar in the short term (Dyhrberg, 2015). As a follow-up research topic (Baur et al., 2018), scholars employed GARCH volatility analysis and concluded that Bitcoin was neither correlated to gold nor other mainstream investment assets (stocks, bonds, currency, etc.) in terms of returns. It asserted that Bitcoin *has unique risk-return characteristics*. However, the research did not assert that Bitcoin necessarily qualified as being similar to gold based on that property alone, but *rather resemble a highly speculative asset*.

A recent 2018 paper which implemented a BEKK-GARCH model to determine the properties between Bitcoin and gold deduced that the former does not *reflect any distinctive properties of gold other than asymmetric response in variance*, and found no *stable hedging capabilities* (Klein et al., 2018). Another paper in 2019 that aimed to tackle the question of whether Bitcoin is a safe-haven asset and its similarities with gold noted varying results stemming from the diverse spectrum (spanning from 2020 to 2018, across developed and

developing markets) of time periods and equity indices under consideration (Shahzad et al., 2019).

Gold, as a financial asset, has played a vital role in the international financial system for centuries, and has consistently and credibly shown correlation to various macroeconomic variables. On the other hand, since the rise of Bitcoin and its price only occurred in the past half decade, resulting in its establishment as a mainstream asset through wider adoption, there has only been a handful of past research carried out to discuss the determinants of its price movement. Most of the studies focused on discussing the nature of Bitcoin as an asset and the underlying decentralized blockchain technology behind it. Few studies have been conducted to probe into the factors that drove Bitcoin prices up and its correlation with various macroeconomic variables. Hence, in this study, the researcher provides a different perspective on examining bitcoin's price reaction to macroeconomic variables that are proved to be correlated to gold according to empirical studies and there are four main research questions and discussions this study would like to address:

- 1) Does bitcoin react similarly to gold against the six macroeconomic variables included in this study?
- 2) Which macroeconomic variable has the largest impact on Bitcoin and Gold?
- 3) The hedging performance of gold in the observed time span of this study. Is gold still a legitimate inflation hedge in the current financial market?
- 4) Provide insights to the role of bitcoin and gold in the current and future financial market.

## CHAPTER III

### Data and Methodology

#### *Data*

The following variables are retrieved from FRED from St. Louis Fed (with its series ID) with their monthly average (Modify frequency: Monthly) and the time span between 2015/2 to 2021/11 (a total of 82 observations):

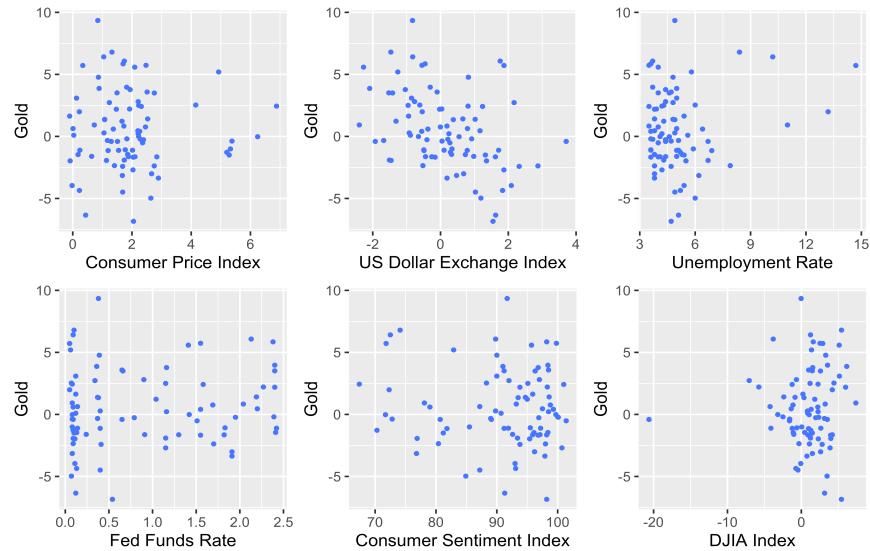
- Coinbase Bitcoin (CBBTCUSD)
- Gold Fixing Price 3:00 P.M. (London time) in London Bullion Market, based in U.S. Dollars (GOLDPMGBD228NLBM)
- Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL) (Percent change)
- Nominal Broad U.S. Dollar Index (DTWEXBGS)
- Unemployment Rate (UNRATE)
- Federal Funds Effective Rate (DFF)
- University of Michigan: Consumer Sentiment (UMCSENT)
- Dow Jones Industrial Average (DJIA)

	Bitcoin	Gold	Inflation based on CPI	USD Index	Unemployment Rate	Fed Funds Rate	Sentiment Index	Dow Jones Industrial
<b>Mean</b>	10848.308049	1411.174434	1.921692	113.321922	5.081707	0.872073	90.878049	24168.230366
<b>Median</b>	6632.365	1296.321537	1.75787	113.44985	4.7	0.405	93.45	24558.955
<b>Maximum</b>	60722.93	1968.565	6.88047	123.3006	14.7	2.42	101.4	35848.57
<b>Minimum</b>	234.37	1068.252632	-0.10403	105.1687	3.5	0.05	67.4	16299.9
<b>Std. Dev.</b>	15469.183022	254.897778	1.415854	3.636358	1.952657	0.832665	8.748475	5387.163965
<b>Skewness</b>	1.968842	0.778037	1.361213	0.073982	2.910025	0.603669	-1.063627	0.395648
<b>Kurtosis</b>	2.756293	-0.878007	2.23409	0.189012	9.68622	-1.17783	0.032301	-0.702915
<b>Jarque-Bera</b>	83.683359	10.910312	45.368529	9.549637	3.644709	0.323444	16.080447	461.834076
<b>P-Value</b>	0	0.004274	0	0.00844	0.161645	0.850678	3.22E-04	0

**Figure 1** Descriptive Statistics



**Figure 2** Correlation of Bitcoin Price (percent change) and Other Variables



**Figure 3** Correlation of Gold Price (percent change) and Other Variables

Despite there are a large quantity of macroeconomic variables that are proved in empirical studies to be correlated to gold, the researcher cherry-picked six variables and will explain the rationale behind the selections below. For the six macroeconomic variables, scatter plots are provided above for readers to have a grasp of the approximate relationship between bitcoin/gold and each variable.

**Inflation Rate:** From Figure 3, the results resemble the intuition that when the inflation rate is higher, it means a higher opportunity cost to holding cash such as the US dollar, which precious metals like gold's value will rise higher when the inflation rate is high. On the other hand, it is indicated in Figure 2 that bitcoin has a slightly positive correlation with the inflation rate despite it is still not obvious. The inflation rate is undoubtedly included in our model as this is the variable that is usually considered to possess the strongest correlation with gold/bitcoin. It is also the variable we are most interested to see how bitcoin's price movement reacts to in our model.

**US Dollar Exchange Index:** From Figure 3, the results resemble the intuition that gold's price usually acts negatively with the US dollar value. When the value of the US Dollar goes up, it will reflect on the price of gold as it now takes less US dollar to buy the commodity; that is, the price of gold will decrease when the dollar increases its value, and vice versa. From Figure 2, we can see that there a slight negative relationship between Bitcoin and US dollar in the past 7 years, and it would be interesting to see how Bitcoin responds to US Dollar Index in our model.

**Unemployment rate:** According to multiple empirical studies, there is a slight positive correlation found between gold and the unemployment rate in recent decades. Thaver, Ranjini L. and Lopez, Jimmie (2017) indicated in their study that during the time span between 2008 – 2016, the price of gold increased by 4.7% for every 1% change in the unemployment rate. From Figure 3, the results indicate that when the unemployment rate is low which is between 3% to 6%, there is a slight negative correlation between gold and the unemployment rate. Nevertheless, gold shows a strong positive correlation to the unemployment rate when the unemployment rate breaks 6%. From Figure 2, it can be indicated that bitcoin reacts to the unemployment rate

similarly to gold, while showing low correlation under a low unemployment rate, it also rewards positive returns under a high unemployment rate environment.

**Fed Funds Rate:** From Figure 3, it can be indicated that there isn't a strong correlation between gold and fed funds rate. Nonetheless, it can be justified since the fed funds rate can stay at the same level for a long period, which gold price may only react negatively to a fed funds rate raise announcement. Take the current market for instance, FED has warned investors for multiple rate hikes as the inflation rate skyrocketed in the past year. As a result, ticker symbol GLD is currently the most bought ETF of 2022 as many investors turned to gold for safety. When the fed funds rate is high, it means there is a higher opportunity cost for holding non-interest-bearing assets, such as gold. Rising interest rates will make bonds and other fixed-income investments more attractive, which money will flow into higher-yielding investments and out of gold when rates move higher. Therefore, the price of gold tends to move lower when the fed funds rate goes higher, which is a negative correlation. From Figure 2, it is also shown that Bitcoin surprisingly has a strong negative correlation with the fed funds rate. Thus, the fed funds rate is included in our model as it is usually considered as one of the vital variables in empirical studies that changes gold's price which the negative relation is proved by the scatter plot.

**Consumer Sentiment Index:** From Figure 3, it can be indicated that the relationship between gold and consumer sentiment index resembles the intuition as they have a negative relation. When the consumer sentiment for the market is high, investors usually put their money into assets that are riskier than gold as they tend to believe that they can earn higher returns with lower risks in these financial instruments, and vice versa. Thus, the demand for gold will be

lower when the consumer sentiment is high, which is a negative relation. From Figure 2, Bitcoin also shows a negative correlation with consumer correlation.

**Dow Jones Industrial Average Index (DJIA):** From multiple past studies such as what He et al. (2018) indicated; it is referred that gold has a small negative correlation with the stock market such as the Dow Jones Industrial Average Index. On the other side, Xin Wang & Xi Chen & Peng Zhao, (2020) indicated that Bitcoin has shown a strong relationship with the stock market, which S&P500 and DJIA especially has an advantageous effect on Bitcoin's price movement. According to our results from Figures 2 & 3, bitcoin is found positively correlated with DJIA Index and gold is found negatively correlated with DJIA Index which matches the results of previous studies.

## ***Methodology***

### ***(a) Normality Test***

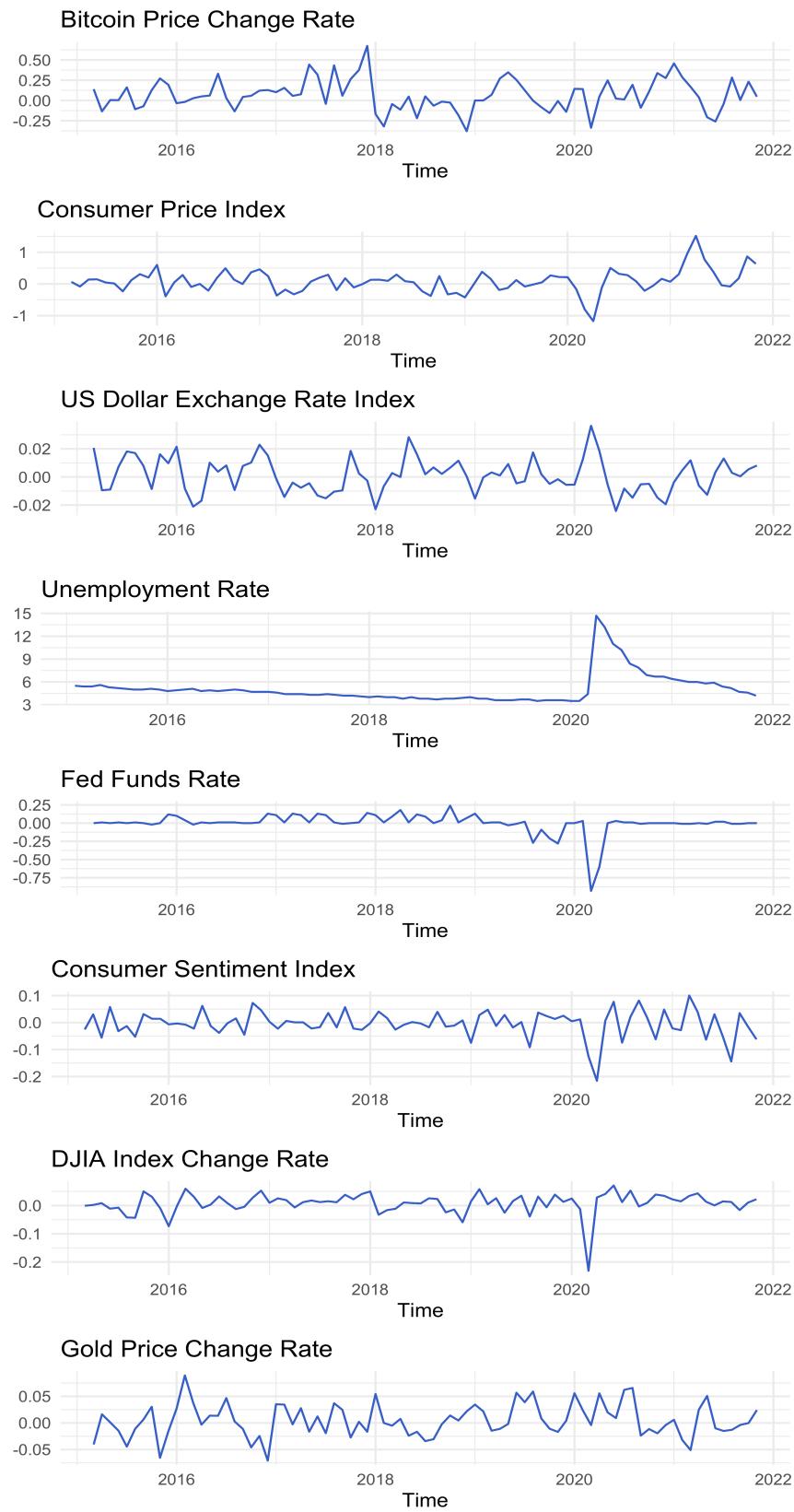
In order to ensure that the variables that are used in the model are normally distributed, a normality test is often conducted to equate skewness and kurtosis. In this case, the Jarque-Bera test is conducted as the results of the normality test are shown above in Figure 1 along with the descriptive statistics. The null hypothesis of the Jarque-Bera test is that the time series data is normally distributed. From Figure 1, it is shown that only the unemployment rate and the fed funds rate have a p-value over 0.05, which makes them normally distributed. However, bitcoin, gold, inflation rate, consumer sentiment index, and Dow Jones Industrial Average Index are not normally distributed and thus the log transformation is applied to each time series data once.

### ***(b) Stationarity Test***

When conducting a time series analysis, stationarity (consistent variance and autocorrelation structure) is often assumed as it allows for a more feasible analysis due to its simplicity. Thus, stationary tests were conducted before the model was built to check whether the time series data possess a unit root and non-stationary, which the Augmented Dickey-Fuller Test (ADF) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) are the two tests used in this analysis. Bitcoin, gold, inflation rate, fed funds rate, consumer sentiment index, and Dow Jones Industrial Average Index was tested to be non-stationary at level and thus differenced once to eliminate the unit root and turned stationary. The unemployment rate is the only variable that is stationary at level. The stationary dataset used in our model is shown below in Figure 4.

### **(c) Cointegration Test**

Next, the cointegration test is conducted to check whether there is cointegration, which is long run linear relationship between the time series dataset included in our model. The results also determine which model will be used. When there exists cointegration between the time series dataset, the VECM model will be used; however, when there doesn't exist cointegration within the dataset, the VAR model will be used since the coefficient matrix for the first lag in the VECM model is zero. Since this study is dedicated to assessing the relationship of how bitcoin and gold react to macroeconomic variables respectively, there will be two sets of models: 1) Bitcoin with the six aforementioned macroeconomic variables and 2) Gold with the six aforementioned macroeconomic variables. Thus, the Johansen cointegration test has been run for both models and the following are the results.



**Figure 4** Stationary Dataset Plot

	<i>test</i>	<i>10pct</i>	<i>5pct</i>	<i>1pct</i>		<i>test</i>	<i>10pct</i>	<i>5pct</i>	<i>1pct</i>	
$r \leq 6$	4.10	7.52	9.24	12.97		$r \leq 6$	1.81	7.52	9.24	12.97
$r \leq 5$	11.17	17.85	19.96	24.60		$r \leq 5$	6.86	17.85	19.96	24.60
$r \leq 4$	26.01	32.00	34.91	41.07		$r \leq 4$	20.25	32.00	34.91	41.07
$r \leq 3$	45.26	49.65	53.12	60.16		$r \leq 3$	41.34	49.65	53.12	60.16
$r \leq 2$	72.47	71.86	76.07	84.45		$r \leq 2$	70.60	71.86	76.07	84.45
$r \leq 1$	103.15	97.18	102.14	111.01		$r \leq 1$	106.72	97.18	102.14	111.01
$r = 0$	165.69	126.58	131.70	143.09		$r = 0$	167.18	126.58	131.70	143.09

**Figure 5** Johansen Cointegration Test for Bitcoin Model

**Figure 6** Johansen Cointegration Test for Gold Model

The null hypothesis of the Johansen Cointegration Test is that there are less than  $r$  cointegrations in the model. From Figure 5, it can be indicated that the bitcoin model fails to reject the null hypothesis starting from  $r \leq 2$  at the 5% significance level, meaning that there are 2 cointegrations in the model. On the other side, from Figure 6, it can be indicated that the gold model fails to reject the null hypothesis starting from  $r \leq 2$  at the 5% significance level, meaning that there are 2 cointegrations in the model.

#### (d) VECM model

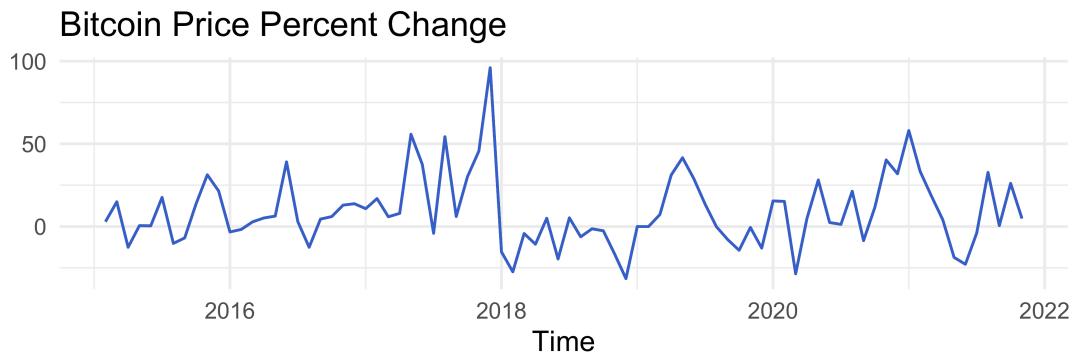
Since cointegration exists between variables in both models, a reduced Vector Error Correction Model (VECM) model is employed. Both models are comprised of 7 variables, and it is given by:

$$y_t = c + Ay_{t-1} + \Gamma_1 y_{t-1} + \Gamma_2 y_{t-2} + \dots + \Gamma_p y_{t-p} + \epsilon_t,$$

where  $y_t$  is a  $(7 \times 1)$  vector of variables,  $c$  is a  $(7 \times 1)$  vector of constants,  $A$  is the coefficient matrix for the first lag,  $\Gamma$ 's are  $(7 \times 7)$  matrices of coefficients, and  $\epsilon_t$  is a vector containing the structural shocks. The lags for the models are selected based on the “lagselect” function in R,

which the lag with the lowest AIC (Akaike Information Criterion) will be selected. As a result, both the model of Bitcoin and Gold are included with 6 lags.

#### **(e) Heteroskedasticity test**



**Figure 7 Bitcoin Price Percent Change Plot**

From Figure 7, it can be implied that the return of bitcoin has been highly volatile throughout the time span, while there are certain periods when bitcoin's price movement is huger than other periods. Thus, there is a high possibility that the variance error of the bitcoin model is believed to be serially autocorrelated, and a heteroskedasticity test comes in handy to check whether the variance error item has to be adjusted to remove heteroskedasticity in our model. The results of the heteroskedasticity (ARCH) test of both the bitcoin and gold model is shown as following in Table 1.

ARCH (multivariate)	Chi-Squared	p-value
Bitcoin	795.26	0.3822
Gold	840.82	0.07805

**Table 1 ARCH Test Results**

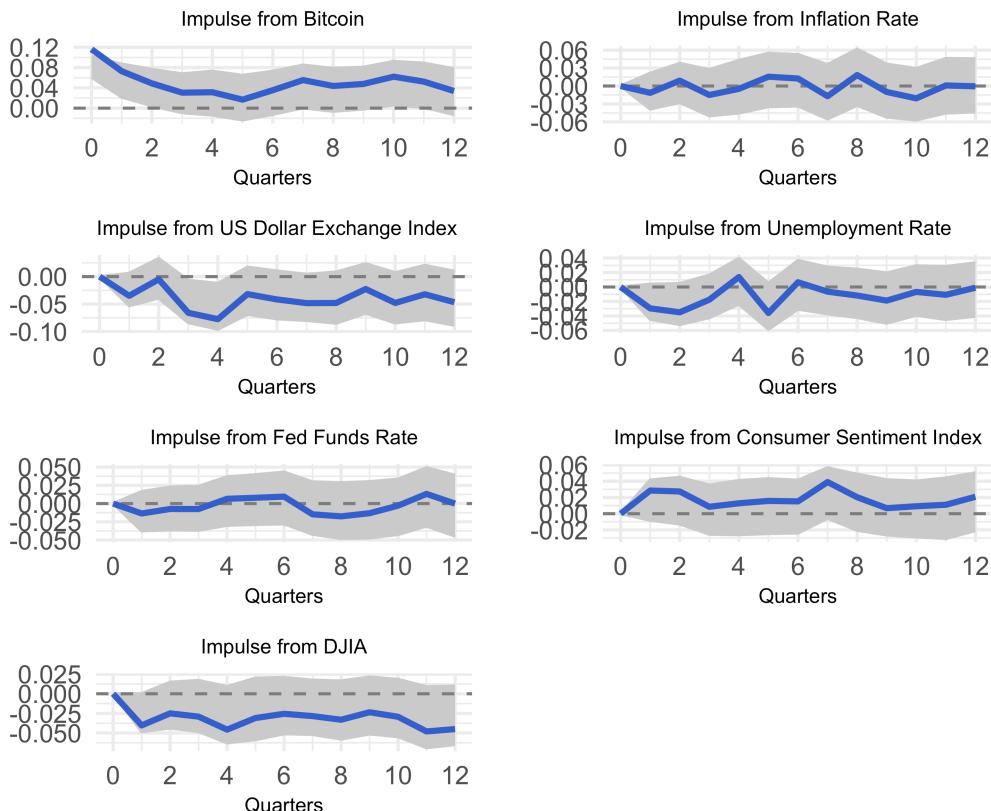
The null hypothesis of the ARCH test is that a series exhibits no conditional heteroscedasticity (consistent variance). Hence, from Table 1, both the bitcoin and gold models fail to reject the null hypothesis, implying that ARCH effect does not exist in both models.

## Chapter IV

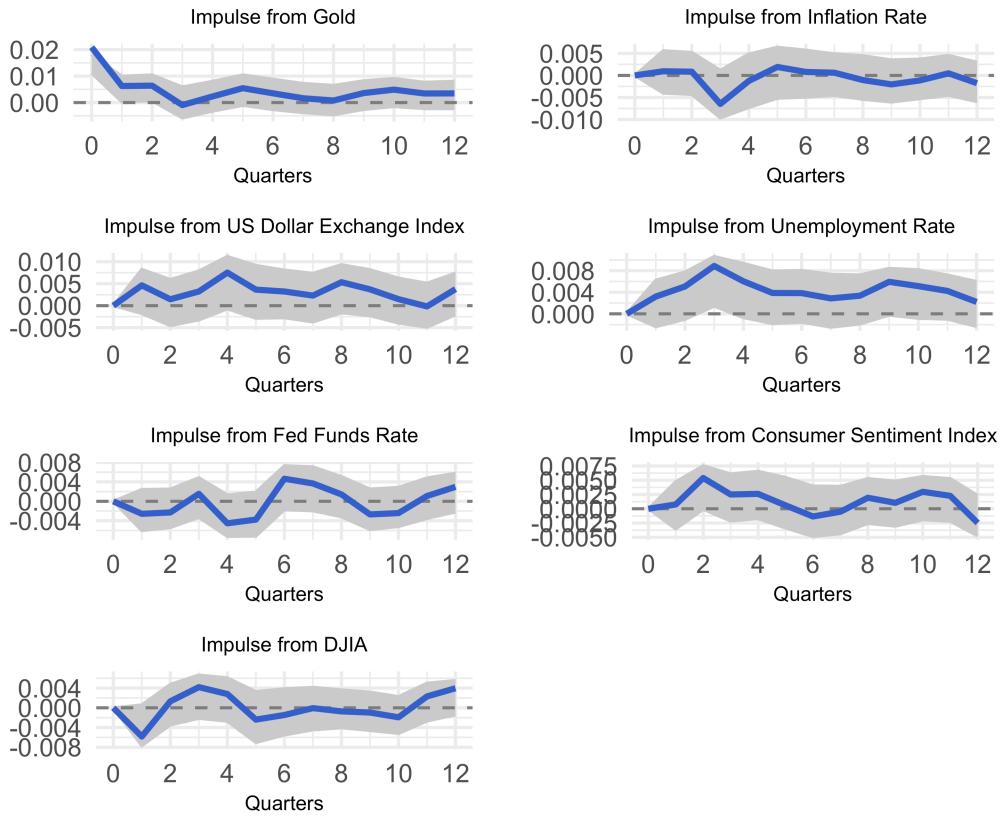
### Results and Analysis

#### **Impulse Response Function (IRF)**

Since the relations between variables in the VAR/VECM model are difficult to observe directly through parameter indices, impulse reaction functions (IRF) is a useful tool to assist researchers in interpreting the results of VAR/VECM models. Impulse reaction function is a counterfactual experiment, which traces the marginal effect of a shock from one variable to another variable while keeping other variables unchanged, allowing the evaluation of the response of a variable to such an impulse over a certain time horizon (Lütkepohl H, 2010.). By the application of impulse response function, bitcoin and gold's response to the macroeconomic variables can be measured respectively.



**Figure 8** Impulse Response Function for Bitcoin



**Figure 9 Impulse Response Function for Gold**

Figure 8 & 9 indicates the impulse response function (IRF) of Bitcoin and Gold to the macroeconomic variables in the model where the gray shaded area corresponds to the 95% confidence bands. The quarters in the figures use a month as the unit.

### ***Impulse from Bitcoin and Gold***

Both bitcoin and gold's price responded to an impulse from itself significantly in the first 2 quarters. For bitcoin, the response bottomed at the fifth quarter but rebounded afterward and remains positive after twelve quarters; for gold, the response bottomed at the third and eighth quarters as the response slowly died out after twelve quarters. As a result, both bitcoin and gold responded positively to a shock from themselves, with bitcoin owning a slightly more lasting impact.

### ***Impulse from Inflation Rate***

Bitcoin responded inexplicably to a positive shock from the inflation rate, hovering around the 0.00 line throughout the 12 quarters but ends slightly positive eventually. On the other side, gold responded negatively as its price drops 7% in the first three months in response to an inflation rate shock. As a result, bitcoin's capability of an inflation hedge is uncertain while gold is not an inflation hedge for the sample period in this study.

### ***Impulse from US Dollar Exchange***

Bitcoin and Gold presented completely contrasting results to the impulse from US Dollar. Bitcoin responded negatively for the entire 12 quarters as its price drops at most to approximately 7.5% after 4 months. Gold surprisingly moved along with US Dollar as the impact peaked at approximately 0.75% up after 4 months and slowly dies out afterward. As a result, it suggests that bitcoin has been a useful hedge against US Dollar while gold failed to hedge against US Dollar for the past 7 years.

### ***Impulse from Unemployment Rate***

Bitcoin and Gold also showed distinct results to the impulse from the unemployment rate. Bitcoin responded negatively for most of the 12 quarters while gold responded significantly positively as its price increases roughly 8.5 % after 3 months. This implies that gold has shown characteristics of a legitimate safe-haven asset as the unemployment rate usually peaks during extreme times of financial crisis or market turbulence.

### ***Impulse from Fed Funds Rate***

Bitcoin reacted negatively for the initial 4 quarters, hovered around the 0.00 line for the next 6 quarters, and ended up reacting slightly positively. Gold reacted negatively for the first 5 quarters, hovered around the 0.00 line for the next 5 quarters, and ended up reacting positively. Since both bitcoin and gold respond inexplicably to the impulse from the fed funds rate, there is no specific takeaway for the variable fed funds rate.

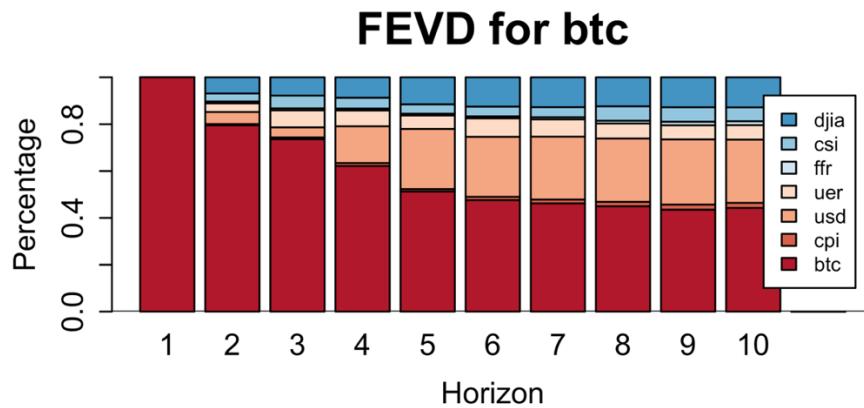
### ***Impulse from Consumer Sentiment Index***

Bitcoin and Gold exhibited similar results to the impulse from the consumer sentiment index with bitcoin responding with a larger magnitude. Bitcoin responded positively throughout the entire 12 quarters, while the price reaction peaked at approximately 4% after 7 quarters. Gold also responded positively for most of the 12 quarters, while the price reaction peaked at 0.5% after 2 quarters. The result of bitcoin in this study contrasts to past studies, in which Shaen Corbet, Charles Larkin, Brian M. Lucey, Andrew Meegan & Larisa Yarovaya (2020) stated that Bitcoin tends to react positively to negative news. The result of gold also contrasts our intuition that investors tend to rotate their funds to riskier assets during times of high consumer sentiment.

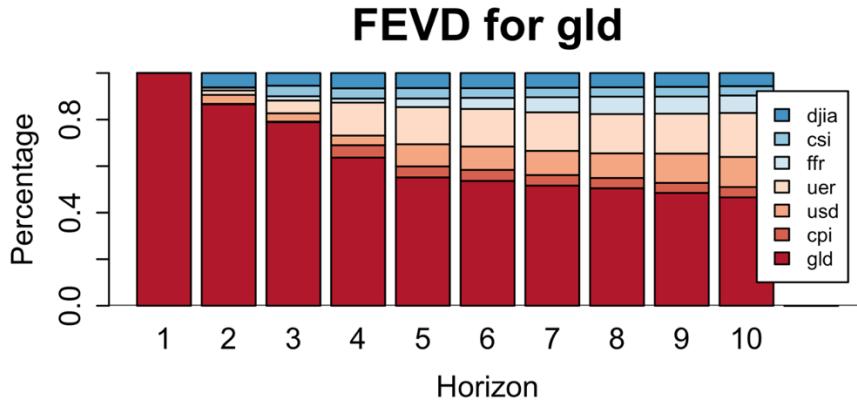
### ***Impulse from DJIA Index***

Bitcoin responded negatively for the entire 12 quarters to the impulse from DJIA Index. On the other side, gold responded negatively at the first 2 quarters, rebounded to positive areas for the next two quarters, turned negative once again but ticked up positively for the last two quarters. As a result, bitcoin is qualified as a hedge against the stock market while the hedging capabilities of gold against the stock market is uncertain.

### *Forecast Error Variance Decomposition (FEVD)*



*Figure 10 Forecast Error Variance Decomposition for Bitcoin*



*Figure 11 Forecast Error Variance Decomposition for Gold*

Forecast error variance decomposition is provided in adjunct to the impulse reaction functions of bitcoin and gold as FEVD provides a holistic view with the proportions of the partial impact of each variable in the model to the total impact. The FEVD is provided above as Figure 10 and Figure 11 which the horizon uses a month as the unit.

It is evident from Figure 10 that bitcoin's own shock has a huge influence on the price movement of bitcoin regardless of short term or long term. For instance, in months 2 and 3, the impulse of bitcoin still accounts for around 70%, while the downward trend consolidated after month 6 at around 45%. Disregarding the impact from bitcoin itself, US Dollar Index has the

largest impact on bitcoin after 12 months for approximately 26.4%, which DJIA index comes in second at around 14.4%. This resembles and strengthens the argument from the impulse reaction functions that bitcoin had been an effective hedge against the US dollar and the stock market. From Figure 11, in a similar way to bitcoin, the fluctuation of gold's price is also highly dependent on its own shock. In months 2 and 3, the impulse of gold still accounts for around 80%, while the downward trend also consolidated after month 6 at around 50%. Outside of gold itself, the unemployment rate has the largest impact on gold after 12 months for approximately 20.6%, which US Dollar Index comes in second at around 12%.

## Chapter V

### Conclusion and Discussion

Bitcoin was first introduced to the public back in 2009 by Satoshi Nakamoto as a peer-to-peer digital cash system that allows users to skip intermediaries and make direct transactions. The brief history of bitcoin, however, has been a true roller coaster ride as it has seen various shifts of prices with unprecedented magnitude compared to any other existing asset. From the first Bitcoin payment of buying 2 pizzas with 10,000 bitcoins to its recent rally of Bitcoin to all-time highs at \$66,000, it has come a long way from being a scam to a speculative asset and with the possibility to becoming a credible asset in everyone's portfolio. Moreover, with similar characteristics and functions with gold, bitcoin has been honored with the title of "Digital Gold". Bitcoin's market capitalization has skyrocketed to \$700+B within 12 years, while it is still way lesser than gold's market capitalization of \$11+T, it is certainly large enough as a financial asset to impact the financial market and react to major macroeconomic factors.

Hence, the major objective of this study is to observe the relationship of bitcoin with macroeconomic variables that has proven correlation in empirical studies with gold. To achieve the stated objectives, the researcher has collected monthly data of bitcoin, gold, and other macroeconomic variables with the sample period from 2015/02 to 2021/11 from FRED. The researcher conducted several tests to clean and process data before constructing the Vector Error Correction Model (VECM model): 1) Jarque-Bera Test: normalize time series data with log transformation, 2) Augmented Dickey-Fuller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test: ensure the time series data does not possess a unit root and is stationary, 3) Johansen Cointegration test: check whether variables in the model has a long run linear relationship with one another, 4) Heteroskedascity test: check and address volatility clustering

issues within the dataset. Next, the researcher explained the underlying relationship between bitcoin/gold and other macroeconomic variables with functions of the VECM model, Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD).

According to the IRF results, bitcoin and gold only demonstrated similar patterns in response to the fed funds rate and consumer sentiment index. Bitcoin responded negatively to US Dollar Index, DJIA Index, and Unemployment rate; responded positively to consumer sentiment index; and responded inexplicably to inflation rate, fed funds rate. On the other hand, gold responded negatively to inflation rate; responded positively to US Dollar Index, unemployment rate, consumer sentiment index; and responded inexplicably to fed funds rate, DJIA Index. With IRF and FEVD results combined, there are two main takeaways from this study:

**1) Bitcoin has strong hedging capabilities against US dollar depreciation and the stock market.**

According to Figure 8, an impulse of US Dollar and DJIA index will drive Bitcoin's price downwards by 5% after 12 months, vice versa, which implies that bitcoin is a hedge against US Dollar and DJIA Index. In fact, with fiscal stimulus and quantitative easing ongoing in the US economy since the outbreak of the COVID-19 pandemic, the US dollar has been facing downward pressure and depreciating against major currencies around the world while bitcoin had a great run making all-time highs in November. Moreover, FED is expected to raise the fed funds rate in the year 2022 multiple times to combat the high-flying inflation rate caused by the easing financial policies. Even though stocks, in general, had experienced two magnificent years along with cryptocurrencies, it is highly possible for stocks to perform weakly after multiple rate hikes. It would be interesting to observe whether Bitcoin and other cryptocurrencies can live up to being a stock market hedge by then.

## **2) Gold is not a perfect hedge against inflation for the current financial market.**

Gold had become investor's first thought of an inflation hedge after its incredible spike in the 1970s during a high inflationary environment. As a precious metal with limited supply, gold has a store of value in nature, which is intuitively considered to be a hedge against currencies which does not hold fundamental value itself. Various empirical studies had also backed the positive correlation between gold and inflation. However, in recent times the conception that gold retains value under an inflationary environment and in times of economic turmoil has been called into question; its price action can be described as less than ideal in comparison to other asset classes, climbing by a mere 13.5% and before plateauing and struggling to break technical resistance ever since the financial crisis triggered by the outburst of Covid-19 in March 2020. Studies like Erb, Claude B., and Harvey, Campbell R.(2013) also pointed out that gold is considered a good inflation hedge over any of our investment horizons, which the study indicated that gold's capability of hedging against inflation is not as robust as in the past and shorter investment horizons. In fact, in this study, according to the results of Figure 9, gold responded negatively to the inflation rate where the price dropped at most by 0.5% after four months. In Figure 11, it is also apparent that inflation accounts for a low proportion of impact on gold's price fluctuations. The two results combine demonstrated that gold corresponds to the abovementioned study that gold is not a perfect hedge for inflation in the current financial market.

From our model's standpoint, it can be seen that the macroeconomic variables that influence bitcoin's price movement are not necessarily identical with gold's. With 12 years of development of the cryptocurrency market and community, bitcoin has gradually matured but has yet to realize the potential of what the founders anticipated it to become as an asset. For

instance, bitcoin has shown great potential as of now but has yet to prove its ability to hedge against inflation as gold has in the past few decades. However, with government regulations, it is foreseeable that the transactions of bitcoin, as well as other cryptocurrencies, become more accountable and transparent for investors. Moreover, with wider adoption of bitcoin from the public, speculative trading will likely decrease leading to lower volatility in the bitcoin market, which may allow bitcoin to achieve the stability and status of gold in the current financial market and maximize bitcoin's potential as an asset in the future. Thus, even though Bitcoin's increase in price seemed to have little to do with inflation at the current stage, this does not imply that it is completely deprived of the potential as a hedge against inflation in the future. Indeed, with ever-growing mainstream adoption and public acceptance, one can speculate that Bitcoin could be the next digital gold or surpass gold to become an unique and irreplaceable asset in the future economy.

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